MACHINERY.

December, 1905.

FACTORY EDUCATION.

O. M. BECKER.

O. M. Becker.

The altruistic movement in the industrial world now gathering impetus is directing attention among other things to the responsibility of employers in respect to the education of their employees. It is a truism not altogether true that the American workingman is the most intelliment in the world. Undoubtedly there is much of truth in the boast, as there is in many another whereby we complacently put ourselves at the head of the procession. The American workingman may well be more intelligent than any other, as might be inferred from his acknowledged superiority as a producer. It does not by any means follow that he is as intelligent as he ought to be or may be. Indeed to one who has had opportunity (and what is more to the point, seriously embraced it) to make a study of the intellectual life and attainments of the employed as a mass, the showing is sadly disappointing. The piecework system, the minute subdivision of productive processes, and the jig—that is to say, the practical elimination of the skilled workman, using the words in their original meaning—these things to a considerable extent discount intelligence, and by the same token, discourage intellectual training. Given the jig, a simple machine, and possibly a little longer practice, the ignoramus can drill a hole as accurately as a college graduate can, and very likely in as short a time. Nevertheless it is universally conceded that in the long run the intelligent workman is the most efficient and therefore the most profitable to the employer.

The present tendency is toward the still further simplification of manufacturing processes, through the use of more complicated machines capable of doing what formerly required several. The manipulation of such a machine undoubtedly requires greater intelligence than that of the simpler one; so that we have the paradox of an increasing requirement for intelligent operatives with a relatively decreasing need for skilled workmen in the sense that a machinist is skilled. Furthermore this specialization of skill, so to speak, this tendency to replace the mechanic with the expert machine tender, obviously requires skillful and discriminating supervision, and at once raises the question as to how such supervision is to be secured. This is not, as might at first thought be supposed, a matter of minor importance, but one that has already come to be quite serious, in the west if not in the east. The reasons are not far to seek.

A visit to any large public school whose pupils come from the homes of wage earners will show that, with an entering class of say two hundred, the finishing or eighth year class will number not far from twenty-five, two-thirds or more of whom are girls. The classes hold up pretty well until about the fourth or fifth year, when a marked decrease in numbers takes place. The children are by this time ten to twelve years old, and are much out of school, even in states where compulsory laws require regular attendance until the age of fourteen or more. If employment laws are strictly enforced, the attendance is better; but even then many are kept out of school on one pretext or another. Usually the real purpose is to have the child do some sort of work which will be either directly or indirectly gainful. Having reached the legal age of exemption from school attendance, usually fourteen, the great majority of these children have not yet completed the eight years' course of the elementary school as they might have done, and except in few cases never do finish it. Most of the boys and a few of the girls at once drift into the factory, and a large percentage of the girls into the department store or office. Except for a very little time set apart in the elementary school course for manual training, these new fledged wage earners have had no training whatever, no preparation fitting them directly for the industrial competition into which they are now thrown and of which they at once become a part. Once in the whirlpool there is little hope that the deficiency in training will ever be made up. The dreadful monotony of factory life, relieved only by the artificial and highly-spiced recreation afforded by the dance hall and similar amusements, soon accomplishes its work, drowning the spirit, if ever there was any, in the hum-drum and noise of piece work—choking the intellectual life as certainly and completely as Niagara's whirlpool might the physical. The evening school and the correspondence school afford some opportunity. It is, however, an opportunity taken advantage of by a few only, the energetic and particularly ambitious who would raise themselves above their surroundings by other means, were these not available. From such as these, and the relatively few who continue their school preparation in preference to entering prematurely the industrial competition and later equip themselves with more or less technical training, the material for expert superintendence of the remaining submerged mass of workers must be drawn. But the available supply no longer equals the demand. Most managers have experienced the difficulty of getting the right man for the place, especially if the place were one requiring considerable knowledge of the business as a whole. An industry is lacking in some respect if it cannot to a considerable extent train up the men who are later to be the directing forces in it. Most businesses are not now doing it. Nor, on the basis of present systems is it possible to be done. The deadening effect of the meaningless repetitive processes which modern production, based on the minutest possible subdivision of labor, seems to make necessary not only destroys individual ambition in the factory hand, but enervates him to such an extent that he instinctively declines responsibility. Take a man from a machine and make him a straw boss or assistant to the foreman, and the chances are even that he will ask to be restored to the machine where he will not be under the necessity of thinking or of shouldering responsibility to which he has never been accustomed. Doomed from the moment he entered the factory door as a boy, he has never acquired sufficient strength to lift his head above his surroundings, and by choice remains among the submerged.

The same condition is manifest in the social and political life, the citizenship of industrial centers, and calls for serious consideration at the hands of publicists and those in control of the great industries. The stability of the existing order of things depends upon strength of character as well as intelligence among the citizenship, and this quite aside from economic considerations as affecting industrial organization. The inability of present school systems and courses to meet adequately the situation in the face of the present day factory

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methods strongly emphasizes the responsibility of employers to do something looking toward a reinforcement of the public school system and a mitigation of the evils resultant from the extreme subdivision of labor.

There are evidently two methods of attack, in the solution of this problem: increasing facilities for industrial and technical education, that is, for the adequate training of workers for their work; and a modification of the piecework system of labor. The latter may be neglected in this discussion for the reason that as yet there appears to be at hand no practicable substitute that is economically as satisfactory. There remains then the other alternative, that of education.

Factory education, or perhaps better stated, the education of factory operatives, is not an untried theory of the idealist. Level headed men have long seen the economic necessity for something of the sort, and as long ago as the time of Robert Owen factory schools were more or less effective agencies in the development of certain industries. The old apprenticeship system, inefficient as it was from the modern point of view, was one manifestation of the idea, and a powerful factor in the promotion of industrial progress. Its wastefulness of time and the development of the specialized machine tool have led to its practical disappearance, unfortunately leaving no organized means for the accomplishment of its purposes in its stead. A few far-sighted employers of large interests, to their great advantage as they stoutly maintain, have retained the apprenticeship system in a modified form, and make it part of an educational system conducted along with and as a part of their manufacturing plants. The Baldwin Locomotive Works, the Browne & Sharpe Mfg. Co., the General Electric Co., and R. Hoe & Co. may be mentioned as notable examples in this country. The school conducted at the Hoe printing press works for more than thirty years, has developed to such an extent that it is recognized as one of the leading private trade schools in the country. Its graduates last June numbered thirty-four, a circumstance which alone would be sufficient to direct attention toward it. In this school, conducted quite outside conventional trade school lines, are trained the young men who make up the working force of a large factory, and among whom there is no lack of material for intelligent and thoroughly qualified superintendence when there is need for it. From it go out, usually after some years additional service with the company, men who take responsible positions in manufacturing plants in all parts of the country. The manager is not well informed who passes by an opportunity to take a Hoe man into his works.

The same things are true to a greater or less extent of the other and lesser developed apprenticeship systems or trade schools conducted by industrial concerns. They not only supply their own needs in the way of skilled men competent to assume responsibility, but in some degree help supply the needs of other employers. Carried on as an integral part of the business, most of the technical and mechanical instruction given by men actually engaged in the production of a commercial output intended to be in competition with similar products, the students or apprentices themselves, working under the identical conditions which they will meet everywhere in commercial shops, such a school becomes not only highly practical and efficient, but a source of profit rather than expense. It is surprising that so few employers have thus far recognized the economical significance of such factory schools, to the extent of establishing them in their own businesses. The present widespread interest in the subject indicates that the time is not far distant when it will receive the careful consideration to which its importance entitles it, and factory education will have become an established fact in all large industries.

But the technical training of employees is only one aspect of factory education. If intelligently carried on, it will necessarily include mental discipline and result in the acquisition of much collateral information. It will not, however, seek to develop particularly on the cultural side. Now it is precisely this, the want of a modicum of culture, the lack of something for the mind to feed upon, that makes the daily life of the factory pieceworker so empty, so monotonous, and so stultifying. His work necessitates practically no thought, and unless he comes to it with some intellectual equipment, or unless there is at hand some means for encouraging the acquisition of it, there is little probability that he will ever rise above himself and develop an intelligence which will make his life more tolerable and his services more valuable. The night schools, as found in the large cities, useful as they are, cannot cope with the situation, for reasons quite external to the schools themselves.

The working hours in manufacturing plants, rarely less than nine, and more often ten a day, together with the strenuous pace required, exhaust the workman to such an extent that very naturally the comfort of home, his "workingman's club," or some place of amusement or relaxation attracts him more strongly than the prospect of some future good through the expenditure of several hours additional effort in a night school. Of course some there are who have the ambition to make the effort. But these are exceptions; and it is with the mass, the average, of working people that we have to deal.

The problem is then to reach, if possible, the great majority of factory people, and to fix the responsibility for reaching them. Now there is no social principle more generally recognized than this, that collective society, through the organized state, is responsible for providing means and agencies through which every individual may be prepared in an elementary way at any rate, for right living—whatever that may mean. The privilege of requiring, within limits not very well defined, all individuals to make use of the opportunities provided, is also universally recognized. On the other hand, there is the undoubted right of the individual to enter upon the business of making a living at as early a time as practicable and consistent with the general welfare of the community. Also to be taken into account is the disposition of workingmen's children generally, whether from need or choice does not here signify, to enter upon an industrial career at the earliest age the state will permit, and therefore with the least preparation permissible. To draw a line of demarkation between the right of the community to the highest possible industrial and civic efficiency, and the right of the individual to determine for himself when he shall enter upon his life work and the amount of preparation requisite for it, is no easy matter. It has been variously drawn, and the tendency is to draw it still further up; that is to say, to lengthen the time required for educational preparation. The cheap market price of child labor naturally inclines the employer to use as much of it as his business will warrant, the supply will permit and the state will allow. From such labor the employer reaps a profit entirely out of proportion with the loss sustained by society; and for his trifling earnings during those years that ought to be devoted to preparation, the individual himself pays the frightful price of condemnation to lifelong intellectual stagnation, slavery to the machine, and relative industrial inefficiency. For these things the employer, it would seem, is in some degree at least responsible, and is under moral obligation to make some return. True, moral obligations are not greatly regarded in business, especially in matters affecting immediate profits. But the folly of permitting so much latent power to go to waste, so much possible productive or executive skill to remain undeveloped, would suggest that it is only prudent foresight to provide some educational means whereby a larger life and greater efficiency may be developed in these individuals.

The extension to employees of educational facilities for development on broad or general lines, in addition to those of a technical character, from this point of view is of prime civic and economic importance and cannot be shirked by the employer who looks to his future interests and those of the community.

How such responsibility is to be met is a problem yet to be solved. Some attempts have been made, many, in fact, since Owen at New Lanark marked the year one of factory education more than a century ago by establishing the first infant school in the United Kingdom for the children of his work people. Few generalizations are to be deduced from the comparatively limited experiences. One thing, however, stands forth clearly; namely, that the efforts, of whatever character they may be, must be mainly directed toward the young, so that the problem becomes practically a boy and girl problem, just as all other education is primarily a boy and girl prob-

lem. The old have their intellectual and physical habits pretty well fixed, and "teaching an old dog new tricks" is proverbially a profitless task. A negative generalization also seems warranted, namely, that evening instruction does not adequately meet the situation. But as to general principles governing the mode of procedure, it would seem that none can as yet be laid down. Perhaps as much as can be done is to indicate what is attempted in some concrete instance; and this I shall try to do in a future article upon the educational work carried on by one of the great manufacturing plants of Chicago.

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FANS.—3.

CHAS. L. HUBBARD.

Effect of Resistance.

The effect of adding resistance to the flow of air from a fan by connecting it with a series of ventilating ducts or the furnace of a boiler is the same as would result from partially closing the discharge outlet.

Carefully conducted tests upon this type of fan have shown that the reduction of air flow is very nearly in proportion to the reduction of discharge area. That is, if the outlet of the fan is closed to one-half its original area the quantity of air discharged will be practically one-half that delivered by the fan with a free opening. Tests also show that the required horse-power varies approximately as the quantity of air discharged. The effect of attaching a fan to the ventilating flues of a building like a schoolhouse, church, or hall, where the ducts have easy bends and the velocity of air flow through them is not over 1,000 to 1,200 feet per minute, is about the same as closing the outlet from 10 to 20 per cent. For factories, with deep heaters and smaller ducts, where the velocity of air flow runs up to 1,500 or 1,800 feet per minute, the effect is equivalent to closing the outlet from 20 to 30 per cent, or even more in very large buildings.

For the average mechanical draft plant, the effect is about the same as for factory ventilation, that is, a reduction of area from 20 to 30 per cent.

In buildings similar to schoolhouses and churches, it has been found in practice that fans of the blower type, having curved floats operate quietly and give good results when run at a speed corresponding to one-half ounce pressure at the discharge outlet; this gives a speed of about 3,600 feet per minute at the circumference of the wheel. Higher speeds are accompanied with greater expenditure of power and are likely to produce a roaring noise or cause vibration. A much lower speed does not provide sufficient pressure to give proper control of the air distribution during strong winds. For factories and similar buildings, a higher pressure of three-fourths ounce or more is generally employed. In the case of mechanical draft, a pressure of three-fourths to one ounce is usually required for forced draft, and from one-half to three-fourths ounce for induced draft.

Example: A schoolhouse requires an air supply of 52,000 cubic feet of air per minute. What size and speed of fan will be required, and what will be the necessary horse power of engine, assuming the resistance to be equal to reducing the discharge outlet 20 per cent?

As the effect of the resistance is the same as reducing the discharge opening, and consequently the air quantity, 20 per cent, we must look in Table VIII. for a fan capable of delivering $\frac{52{,}000}{.8} = 65{,}000$ cubic feet of air per minute. In the column headed ½ ounce pressure we find that an 8 foot fan will deliver 64,550 cubic feet, and is the size we should use.

Table IX. shows us that a fan of this size must be run at a speed of 175 rev. per minute to produce a pressure of ½ ounce. In Table X. we find that 20 horse-power is required to run the fan at a speed to produce this pressure when discharging into free air. Under the conditions of the problem, with the outlet restricted 20 per cent, the required power would be $20 \times .8 =$ 16 H. P.

Actually the pressure is increased slightly by restricting the outlet at constant speed, but this is seldom taken into account in ventilating work as air volume and power required are the quantities sought.

Mechanical Draft.

Theoretically, about 12 pounds of air are required to burn one pound of average coal or coke. In practice, however, with natural draft, it is necessary to supply about twice this amount to secure complete combustion, owing to the difficulty of bringing the air into contact with the entire body of coal. With mechanical draft and deeper fires, this quantity may be reduced to about 18 pounds per pound of coal, which is equivalent in round numbers to 230 cubic feet at a temperature of 50 degrees F. Assuming a coal consumption of 5 pounds per horse-power per hour, calls for an air supply of $5 \times 230 =$ 1,150, or practically 1,200 cubic feet of air per boiler horse-power per hour.

The size of fan and power required for supplying a given quantity of air at a stated pressure may be determined in the same manner for forced draft as illustrated in the preceding example, except that the resistance may be taken as equivalent to a reduction of about 25 per cent instead of 20 per cent in air volume and horse-power, at a given speed or pressure.

In the case of induced draft a correction must be made for the effect of higher temperature of gases passing through the fan. The proper size and speed of fan in this case, together with the power of engine may be found by first computing them for an air temperature of 50 degrees and then making corrections as shown below.

Let us assume the average temperature of the gases from the furnace to be 550 degrees. Referring to Table IV (October MACHINERY), we find that the volume of a given weight of air at this temperature becomes 1.98 times that at 50 degrees (col. 2), and that the peripheral speed of fan required to produce a given pressure is 1.41 times as great (col. 5), also that the necessary power is increased 1.98 times when a properly proportioned fan is used (col. 7).

The horse-power can evidently be obtained at once by multiplying that already computed by 1.98.

As we wish to keep the pressure the same, and to move the same weight of air, it will be necessary to increase the peripheral velocity of the fan by 1.41; the speed required for doing this can be fixed after determining the size of fan. From col. 3 we find that the relative velocity of flow due to the same pressure at this higher temperature is 1.41. Therefore, if the pressure is to remain constant, the volume of air moved 1.98 times as great, and the velocity of flow through the outlet 1.41 times that of air at 50 degrees, the effective area of outlet must be $\frac{1.98}{1.41} = 1.4$ times that of the fan used for delivering the air at the lower temperature.

We may then select a fan having approximately this size of outlet and obtain the necessary speed in revolutions by dividing the required peripheral velocity by the circumference of the fan wheel.

For other temperatures, the method will be the same, although the ratios from Table IV. will vary.

Example: Determine size and speed of fan and power required for driving, used in producing an induced draft of ¾ ounce for a battery of boilers aggregating 670 horse power. $670 \times 1{,}200 = 804{,}000$ cubic feet of air per hour, or $804{,}000 \div 60 = 13{,}400$ cubic feet per minute. Assuming the resistance as equivalent to restricting the area of outlet .25, we must look in Table VIII. under ¾ ounce pressure for a fan delivering $13{,}400 \div .75 = 17{,}866$ cubic feet, where we find that a 4-foot fan will deliver 17,900 cubic feet.

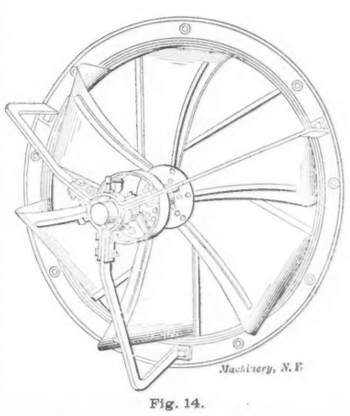

Fig. 14.

Table IX. shows us that a speed of 427 revolutions per minute is required to produce this pressure, and Table X. gives

the necessary power as 9.1, which multiplied by .75 is 6.8, or in round numbers, 7 horse-power.

Assuming the temperature of the gases to be 550 degrees, and referring to Table IV., we find the following ratios or multipliers: Volume, 1.98; velocity due to same pressure, 1.4; peripheral speed to produce same pressure, 1.4; power, 1.98.

The effective area of outlet of a 4-foot fan is $2.24 \times 1.78 = 4$ square feet; therefore the required area is $\frac{1.98}{1.4} \times 4 = 5.6$ square feet. The fan having an outlet area corresponding most nearly to this is a 5-foot, whose outlet is $3.5 \times 1.78 = 6.2$ square feet.

Although this is slightly larger than called for, we can depend upon the automatic regulator to keep the speed at the required point to supply the necessary air volume. The required peripheral speed is 427×12.6 (circumference of 4-foot wheel) $\times 1.4 = 7{,}532$ feet per minute.

The circumference of a 5-foot fan is 15.7 feet; therefore, $7{,}532 \div 15.7 = 480$ revolutions per minute, which is the required speed of the larger fan. The final horse-power is $7 \times 1.98 = 14.8$ or 15 in round numbers.

Disk Fans.

The capacity of a disk fan varies greatly with the type and conditions under which they operate. The rated capacities given in catalogues are for fans revolving in free air, that is, mounted in an opening without being connected with ducts or working against a resistance. Disk fans of the type shown in Figs. 14 and 15, when working against a low resistance such as is commonly encountered in ventilating work where the air is drawn or forced through ducts of medium length at velocities not exceeding 600 or 800 feet per minute, propel the air in a direction parallel to the shaft, a distance equal to about .6 of the diameter for each revolution. From this we have the equation $C = .6\,D \times R \times A$, in which

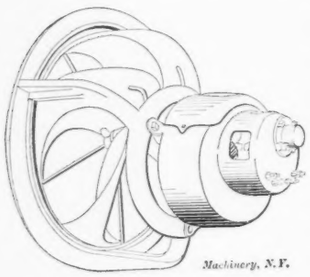

Fig. 15.

C = cubic feet of air delivered per minute,
D = diameter of fan, in feet,
R = revolutions per minute,
A = area of fan, in square feet.

In order to obtain the best results the linear velocity of air-flow through the fan should not average over 1,000 feet per minute, nor exceed 1,200 feet as a maximum.

Table XI. gives the volume of air delivered per revolution for fans of different diameter based upon the above formula:

TABLE XI.

Dia. of Fan.	Cubic feet per Rev.
12 inches	.5
18 "	1.7
24 "	4.0
30 "	7.8
36 "	13.
42 "	21.
48 "	32.
60 "	62.
72 "	108.

The power required per cubic foot of air delivered, depends upon the velocity of flow through the fan.

Table XII. gives the horse-power required per thousand cubic feet of air for different velocities moved through the fan.

TABLE XII.

Velocity through Fan in feet per minute.	Horse-power required per 1,000 cubic feet of air moved.
600	.12
700	.20
800	.30
900	.35
1000	.40
1100	.45
1200	.55

Example: What volume of air will be moved by a 30-inch fan running at 600 rev. per minute, and what horse-power will be required to drive it? $7.8 \times 600 = 4{,}680$ cubic feet per minute.

The area of a 30-inch fan is 4.9 square feet, therefore the velocity of flow through the fan is $4{,}680 \div 4.9 = 955$ feet per minute. At a velocity of 1,000 feet, the power required is .4 horse-power per thousand cubic feet, or for the case in hand $4.68 \times .4 = 1.87$ or in round numbers 2 H. P.

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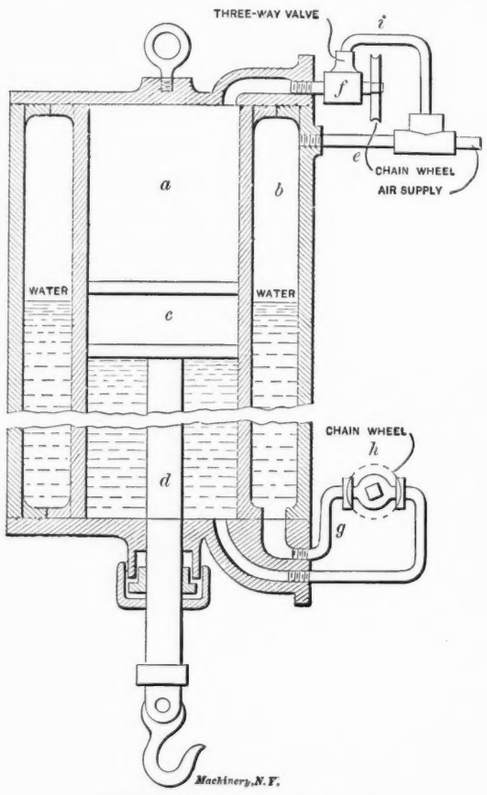
LOBDELL AIR HOIST FOR CASTING LADLE.

For several years hydro-pneumatic air hoists have been in use in the Lobdell Car Wheel Foundry at Wilmington, Del., which are quite satisfactory for the purpose required. These hoists are employed over the casting floor for lifting the ladles to pour the iron into the wheel molds. It is highly necessary that the action be perfectly steady and under instant control. For this reason compressed air alone will not do, for the air under pressure beneath the piston will expand the moment the weight is reduced, and thereby change the height of the ladle. With the hydro-pneumatic hoist all the convenience of compressed air is obtained with the reliability and sureness of action that characterizes the hydraulic hoist. The accompanying diagrammatic sketch and description should convey a clear idea of the principle employed.

The air enters the jacket b above the water through pipe e, which having no valve, allows the pressure to remain on constantly. The air enters cylinder a through pipe i and the



The Lobdell Hydro-pneumatic Hoist.

threeway valve f. This valve can be turned so as to admit air to the top of the cylinder or to exhaust it therefrom. In order for the water in the jacket to pass into the cylinder under piston, or *vice versa*, it must pass through the pipe g and valve h. Of course, when h is closed there can be no movement of the water and consequently of the piston, and the amount of opening given h controls the speed of piston. In operation if it is desired to hoist, the pressure is exhausted from top of the cylinder, through valve f, and the valve h is opened. The pressure now being on top of the water in jacket and none over piston, the water is forced into the bottom of the cylinder and raises piston. In lowering, the exhaust is shut and air admitted through f to top of cylinder and valve h is again opened. The pressure on top of piston now exceeds that on bottom by the pressure on the area of rod and by the weight of piston head and rod. Consequently the water is driven back through g and h into jacket b, and the piston lowers.

VARIABLE SPEED MECHANISMS.—6.

GEARED DEVICES.

When the design of a variable-speed mechanism necessarily includes positive drive, *i.e.*, toothed gearing, the possibility of making changes of speed by small increments is ordinarily thought to be impracticable, and is rarely attempted, although one device, illustrated in this article, outlines a more or less chimerical scheme for making an infinite number of speed changes within certain chosen limits. In friction devices the making of changes by small gradations is simple. The friction surfaces may be conceived as being composed of an infinite number of teeth of very short height, so that no matter what "pitch circles" are brought into contact, there is not the clash that must follow the indiscriminate mating of ordinary gears, of which the teeth are of measurable thickness, and

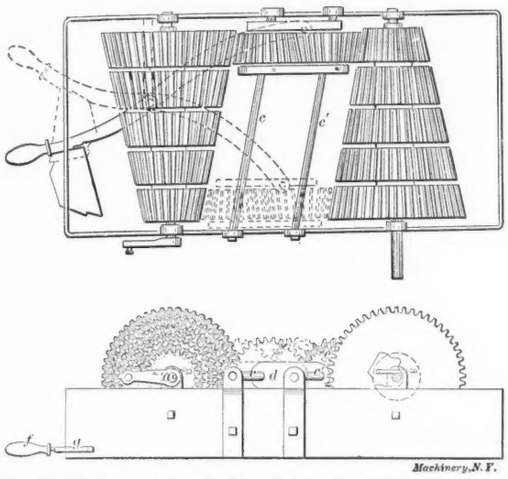


Fig. 58. The Idea of an Idealist. Patent No. 53,202, J. H. Wait, March 13, 1866.

the pitch circle must always be evenly divided. Hence, in gear devices nearly all designs make the changes by steps, which means that a multiplicity of gears of different pitch diameters are required to be so located that pairs representing the desired ratios may be brought into mesh to effect the desired change. The principle difference, therefore, between the various devices here described is in the manner that the change from one step to another is effected. If it were possible to make the changes with the facility that is outlined in patent No. 53,202 granted to J. H. Wait, March 13, 1866, and shown in Fig. 58, the problem of positive speed variation would have been greatly simplified, but the cheerful assurance of this inventor is hardly borne out by the cold mechanical

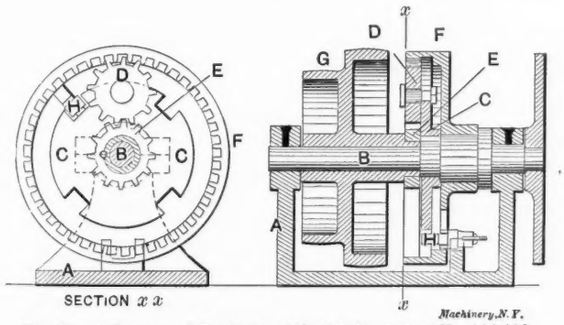


Fig. 59. A Two-speed Device by Alfred Betts, Patent No. 144,499, November 11, 1873.

facts and it is hardly necessary to say that his device for changing speed will not work. One cannot help being struck with wonder why such an impractical device was passed by the patent office examiners, and granted a patent. We hope that such a total lack of mechanical sense is not a characteristic of any of our patent office examiners at the present time.

November 11, 1873, Alfred Betts was granted patent No. 144,499 on a device for changing the speed of machinery. This invention was designed more especially for the needs of machine tools. In Fig. 59 *A* represents the headstock of a lathe, boring mill, drill or other machine tool in the bearings of which is "journalled" a spindle, *B*. To this spindle is keyed a notched disk, *C*, and upon a stud projecting from the notched disk is mounted an idler pinion, *D*. *G* is the usual cone pulley mounted loosely upon spindle *B* and having keyed to one end of its hub the pinion *E*, which meshes into the idler pinion, *D*. *H* is a stop which protrudes through and is adjustable in a slot cut through the side of the internal gear wheel,

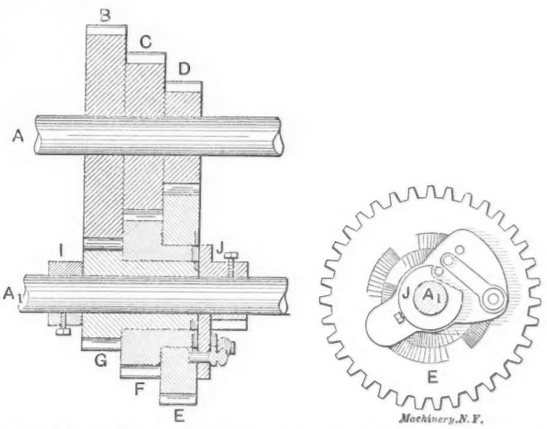


Fig. 60. Patent No. 204,585, granted to S. D. Locke, June 4, 1878.

F. By moving the stop, *H*, into one of the notches of disk *C*, the disk, spindle, and internal gear wheel, *F*, are locked securely together, thus making the cone pulley and spindle turn as one. When the stop is removed from the notched disk and engaged in a notch in the lower part of the headstock, motion is communicated to the spindle, *B*, and pulley, *G*, by the intermediate pinion, *D*, thus "multiplying the power at the expense of speed." In short, this device is a substitute for the familiar back gear generally used for lathes and other machine tools.

Fig. 60 shows a change speed gear patented by S. D. Locke,

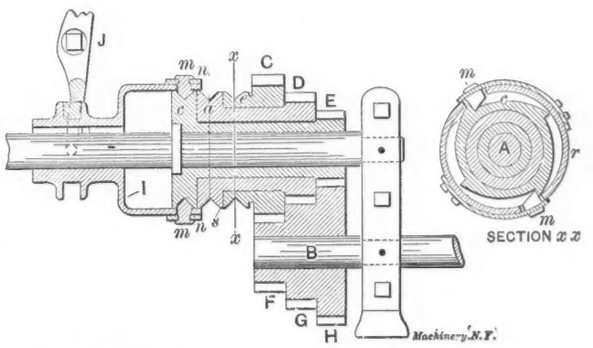


Fig. 61. Device of S. D. Locke, Patent No. 213,338, March 18, 1879.

June 4, 1878, No. 204,585, for grain binders. Two opposing cones of gears, *B*, *C*, *D*, and *E*, *F*, *G*, are mounted on parallel shafts, *A* A_1. Gears *G* and *F* are made with extended hubs so that portions of the right-hand faces of all three gears are in the same plane at the right. A collar, *J*, is secured to shaft A_1, which carries a swinging pin which can be engaged in notches in any one of the three gears, *G*, *F* and *E*. In this manner, three positive changes of speed are provided. The patent, however, is not limited to this particular construction, alternative devices being illustrated in the specifications, one of which provides that changes may be effected by the insertion of pins through both cones of gears in such a way as to lock them and make any opposed pair the driver and driven gears.

Another patent for a geared variable speed device also for agricultural machines was granted to S. D. Locke, March 18, 1879, No. 213,338, and is shown in Fig. 61. This patent provides an interesting method of effecting changes of speed, the changes being made without the necessity of stopping the machine. Gears *C*, *D* and *E* are provided with extended hubs which are circumferentially grooved. The grooves, however, are not continuous, but form in effect ratchet teeth as is shown in the cross section. The sliding sleeve, *I*, is enlarged into a

cup shape at the right end, and is feathered to shaft *A* so that it must turn with it, although free to be moved longitudinally by hand lever, *J*. Two inwardly projecting pins or pawls, *m m*, are provided at the right which engage the teeth in grooves *c*, *a* and *e*. When the hand lever, *J*, is moved so as to shift the sliding sleeve, *I*, the V-shaped pawls, *m m*, ride up over the sides of the grooves and fall into the next one,

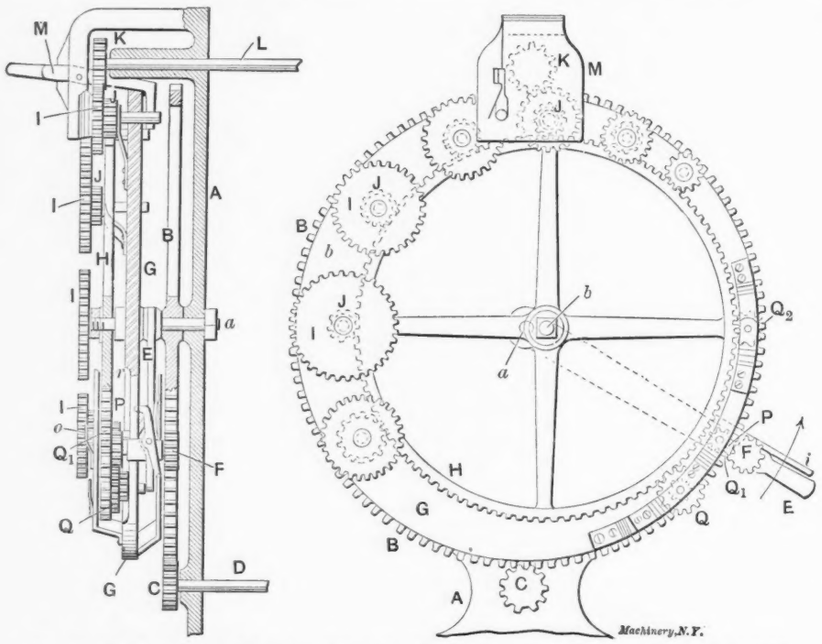


Fig. 62. Feed Changing Mechanism, Patent No. 276,463, granted to B. B. Powell, April 24, 1883.

thus converting that gear into a driver. While the changes of speed are neatly effected, this device has the bad feature that all the gears are running, and one gear being mounted upon another, the friction loss would be a maximum when *C* is the driver, as there would then be the condition of all three gears working under the load and running at different speeds.

The speed-changing mechanism shown in Fig. 62, No. 276,463, was patented by B. B. Powell, April 24, 1883. While primarily designed as a feed-changing mechanism, it will be of interest in this connection, for of course the principles which are valuable in one are equally valuable in the other. In feed-changing mechanisms, however, as is the case with this, it is desirable to provide a large number of changes with comparatively low steps in velocity ratio. The head of the lathe or similar support is indicated by *A*, on which is mounted a center pin, *a*. Upon this pin is loosely fitted a spur wheel, *B*, which engages with and communicates motion to pinion *C* on shaft *D*. Next to and outside of this spur wheel, *B*, is the hand lever, *E*, which is mounted upon the center pin, *a*. This hand lever carries a pinion, *F*, which meshes with *B*. Outside of the lever, *E*, and loose upon the center pin, *a*, is the plain disk, *G*, and outside of disk *G* and mounted on an eccentric pin, *b*, is a spur wheel, *H*. Mounted on *G* are a series of gears and pinions, *J* and *I*, through which motion may be conveyed to *H* by means of pinion *K*. Provision is made for throwing the idle wheels out of engagement with *H* when not acting as intermediates between *K* and *H*. Motion is transmitted from gear *H* to gear *G* and thence to pinion *C* by means of one of the compound intermediate pinions, *Q*, Q_1, Q_2, and pinion *F* mounted on the hand lever, *E*. This lever may be shifted into three positions. To put it in mesh with gears *Q*, Q_1, Q_2, each of which, with the exception of Q_2, effect a change in velocity ratio, in addition to that effected at *M*. With this arrangement it is apparent that twenty-one changes of speed may be effected by changing the position of the disk, *G*, so as to bring various intermediates in mesh with *K*, and by shifting the hand lever, *E*, so as to change the velocity ratio between *H* and *G*.

A changeable speed gearing was patented October 21, 1884, No. 307,002, by H. Bickford and A. Armitage, which is illustrated in Fig. 63. This is another example of a positive change speed gearing for agricultural implements, this device being for grain drills. Motion is transmitted to the gearing by shaft *A*, on which is mounted a pinion, *B*, meshing with five pinions, *F*, F_1, F_2, etc. These latter are mounted in a circular frame, *E*, having notches on its periphery by which any gear may be held in a fixed position relative to *J*. Each of these gears, *F*, F_1, etc., have squared shafts on which an intermediate gear, *G*, can be slipped, so as to communicate motion to *J*. To double or triple the possible speed changes gear *G* is made with two or three steps, and *J*, with its train of gearing, is shifted sideways so as to be in the same plane with the pinion with which it is to be brought in mesh. The mechanism for doing this and for shifting *J* toward the shaft *A* is not clearly shown.

An ingenious method of changing from one speed to another in a geared variable-speed mechanism was patented by R. N. Dyer, September 27, 1898, No. 611,378. The principal of this device is illustrated in Fig. 64, the idea being the use of eccentric gears between the working gears which are used as the means of translation from a low to a high step, or *vice versa*. In the illustration *C*, *D* and *E* represent the three working gears of a cone and *F* and *G* are two eccentric gears of such diameter that two opposite points in their pitch circles osculate with the pitch circles of the adjacent working gears. When it is desired to change the intermediate gear, *I*, from one step to another, it is shifted sideways onto the translating gear when the cone reaches those critical points where the pitch circles of the working gear and translating gear osculate. Then when the translating gear has revolved 180 degrees, gear *I* is again moved sideways so that it comes into full mesh with the gear with which it is desired to work.

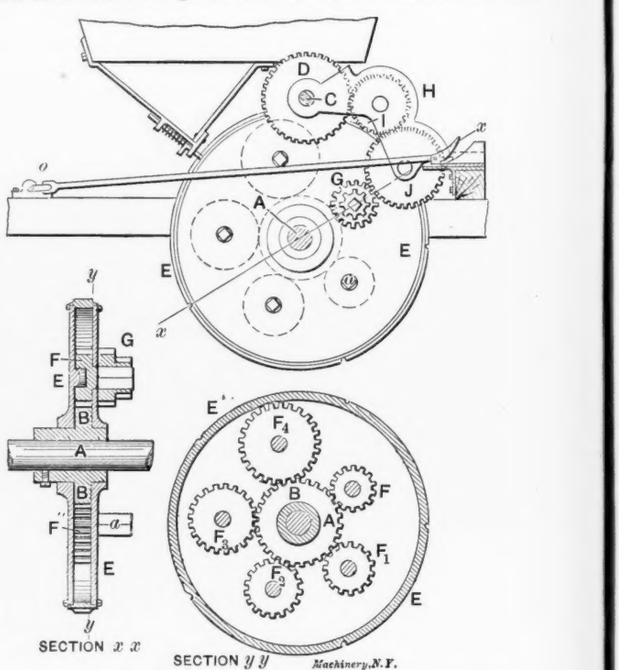


Fig. 63. Patent No. 307,002, granted to H. Bickford and A. Armitage, October 21, 1884.

The means of holding gear *I* in proper relation to both the working and translating gears is also shown, consisting of the friction roller *L* that is mounted on a curved arm forming a part of the arm carrying gears *K* and *I*. Friction roller *L* is always in contact with one of the wheels C_1, F_1, D_1, G_1, E_1, which coincide in diameter and relative position to the pitch

circles of the respective gears. The tendency of the gear *I* to throw out of mesh with the working gears holds the roller *L* against the face of the respective wheel corresponding with the gear with which it is required to work. The mechanism by which the changes are made at the critical periods in the rotation of the gears is not clearly shown in this cut, and being unnecessary for the purpose of illustrating the principle, the drawing showing this is omitted. It will be observed that a valuable feature of this invention is that the change from one step to the next is effected practically without shock, the eccentric gears acting as fairly efficient accelerating or de-accelerating devices.

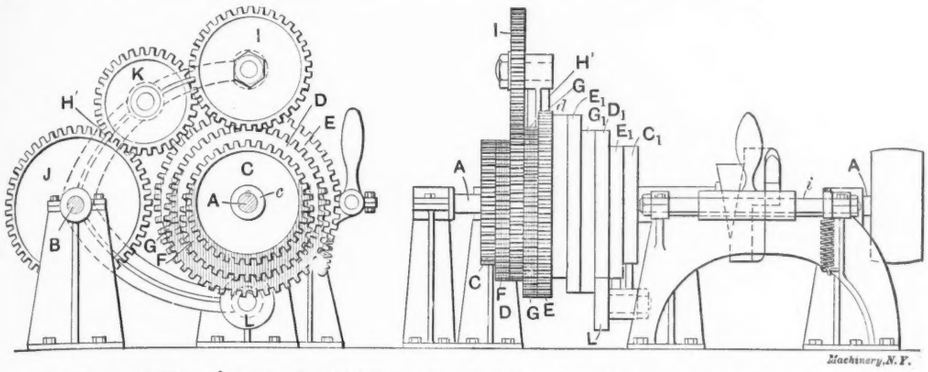


Fig. 64. Speed Changing Device for which Patent No. 611,378 was granted to R. N. Dyer, September 27, 1898.

* * *

A NOVEL WATER HOIST.

At the last meeting of the American Society of Mechanical Engineers, held at Scranton, Pa., a great deal of interest was evinced by the visiting members in the large mine water hoist recently erected at one of the Lackawanna mines at Scranton. The question of unwatering a mine is a serious problem in mine management, especially when the water is impregnated with acids. In the anthracite regions there are mines in which, for every ton of coal raised, as high as 14 tons of water must be pumped. Nowhere, probably, have a greater variety of pumps and lifting devices been tried, and the most satisfactory type, up to date, for handling large quantities of water at comparatively low heads, has proved to be large bailers operated by steam engines. These, however, lack the mechanical regularity of pumps, as they are necessarily operated by men.

The novelty of the new water hoist at Scranton lies in the facts that it is motor driven and that the raising and lowering of the buckets is entirely automatic and occurs at regular intervals, so that the raising of the water is carried on as uniformly as when pumps are employed. The apparatus constitutes what is probably one of the largest automatic machines in existence. Mr. H. M. Warren, electrical engineer of the Lackawanna Railroad, is primarily responsible for the arrangement, but the apparatus was built and the mechanical details carried out by the Wellman-Seaver-Morgan Co., Cleveland. Most of the electrical controlling devices were furnished by the Electric Controller & Supply Co. The specifications called for the hoist to be operated by an alternating-current motor of 800 H. P. and the question of starting, stopping, and reversing so large a motor had to be met at the outset. The duty to be performed by the hoist called for the raising of 4,000 gallons of water per minute to a height of 550 feet, which, with the work necessary to raise the rope and buckets, necessitated 610 net horse power.

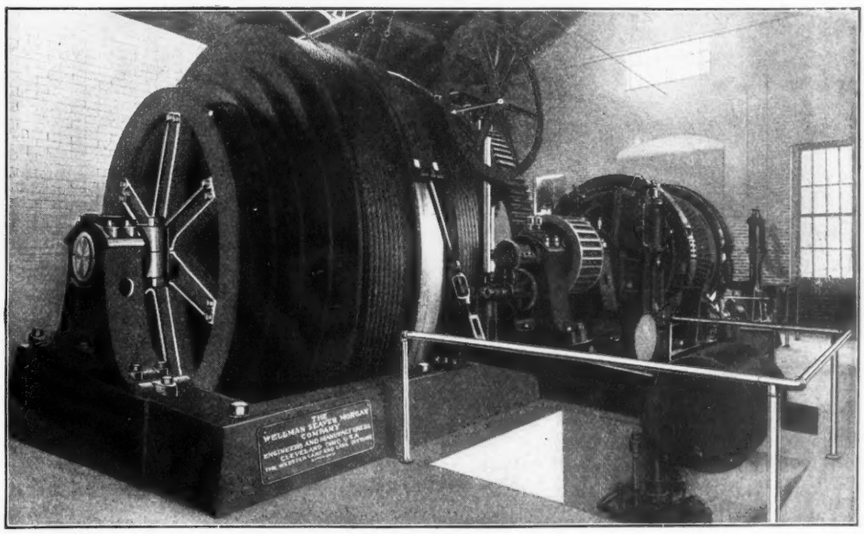


Fig. 1. Side View of Winding Mechanism of Lackawanna Water Hoist.

It was decided that it would be impracticable to do other than run the motor continuously in one direction, as it is a well-known fact that the amount of current required to accelerate a large motor of this type is enormous, and greatly interferes with the running of the power plant. This, therefore, necessitated the use of friction clutches for accelerating and reversing the load, and this was the method followed.

Figs. 1 and 2 show a front and side view of the hoist. As will be noticed, the general arrangement consists of a motor driving a pair of bevel wheels through a single bevel pinion. The bevel wheels run loose on a shaft and are fitted with the well-known Webster, Camp & Lane friction clutches. The operating mechanisms for the clutches are so designed that only one clutch can be thrown in at a time, but both clutches can be out at the same time. Throwing in one clutch runs the drum in one direction; throwing in the other clutch reverses the motion of the drum.

To the shaft on which the bevel wheels run there is keyed a pinion meshing with the main gear on the drum shaft. The drums are 10 feet at the small diameter and 16 feet at the large diameter. There is one main brake located between the drums. All of the clutches and brakes are operated by auxiliary air cylinders fitted with oil cushion cylinders, the compressed air being furnished by a motor-driven air compressor and the necessary tanks located near to the hoist.

The hoist is controlled by a mechanical device shown in Fig. 2. The periods at which this device must operate are, of course, when the buckets are full up and full down, at the end of their travel in each case. To set the controlling mechanism in operation at these times there is a traveling nut which moves along as the drums rotate, and at each end of its travel this nut releases a stop and allows a friction-driven controlling drum to make a quarter turn. This drum is rotated through a friction connection with the motor and the sprocket chain appearing at right in Fig. 2.

This quarter-turn movement of the controlling drum operates solenoids on the clutch valve, through suitable electrical connections, and releases the clutch, and the solenoid on the brake valve sets the brake. At this point a stop which prevented the friction drum from making more than a quarter turn is now moved by the motion of a secondary shaft, timed to the interval required to empty the bucket. This releases

the controlling drum and as it continues to rotate it releases the brake and throws in the reversing clutch, thus starting the hoist in the opposite direction, and also starting the traveling nut of the controlling mechanism in the opposite direction.

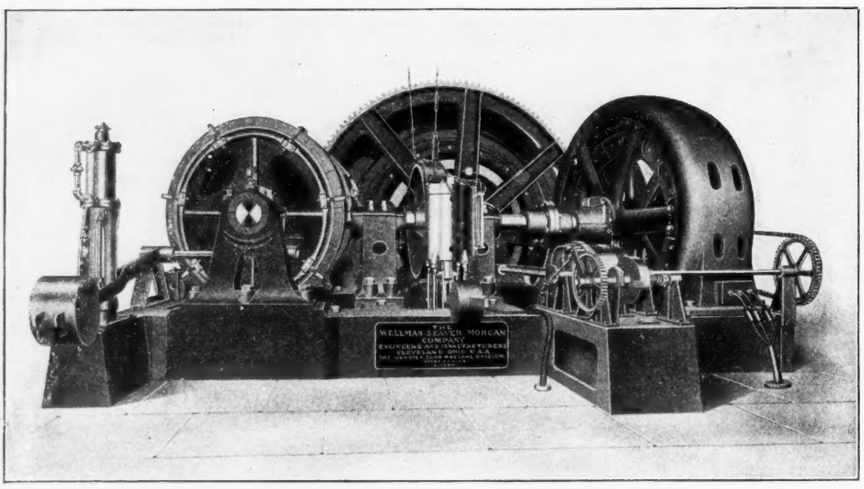


Fig. 2. Front View of Winding Apparatus showing Controlling Mechanism.

If, for any reason, either the supply of current or of air pressure is interrupted, the valve drops, and the weights on the brake lever set the brake. The clutches are designed so that they are thrown out by the weights. As is the case with the brake, either clutch can only be thrown in when the current is on the solenoid, and the air pressure admitted under the piston, and if either current or pressure fail, the clutch is off. The motor shaft is fitted with an emergency brake operated by a weight controlled by a solenoid—any interruption in the flow of current to the motor sets the brake and stops the machine, throws out the clutches and puts on the brake. A safety cut-out is provided for in the head frame so that in case a bucket is carried beyond the proper height, the current is cut off.

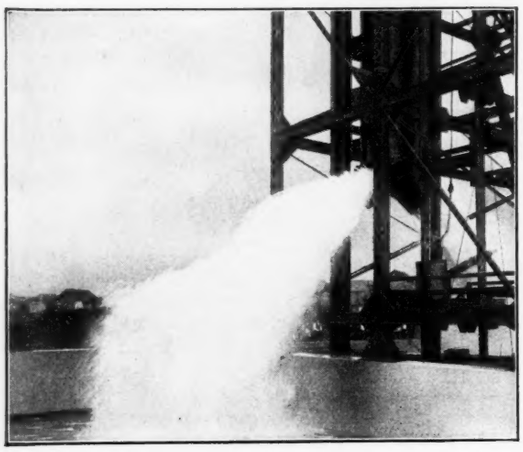


Fig. 3. Bucket Discharging.

Fig. 4 shows the head-frame. This is 93 feet from the base to the center of the sheave at the top. It is built of structural steel, roughly in the shape of an "A." From the head-frame are suspended two buckets 6 feet in diameter and 19 feet 6 inches deep. The capacity of each bucket is 17 tons of water. In the bottom of the bucket are located two lift gates with an area practically equal to the cross section of the bucket. These gates are lifted automatically when the bucket reaches the top, and the water is discharged through the bottom into a spout fitted below the bucket, and which deflects it to either side of the shaft. Each bucket makes a complete round trip in one minute and fifty seconds, the total lift being 555 feet.

Fig. 3 shows a nearer view of the bucket when discharging.

* * *

MEETING OF THE AM. SOC. OF MECHANICAL ENGINEERS.

The fifty-second meeting of the American Society of Mechanical Engineers will be held in New York city during the first week in December. The headquarters instead of being at the society house, 12 West 31st Street, as in previous years, will be at the Edison building, 44 West 27th Street, the two upper floors being used.

The opening session at which President John R. Freeman will present the annual address will be at 44 West 27th Street on Tuesday evening, December 5. The second or business session will be held Wednesday morning in the main saloon of the steamship "Amerika" at the docks of the Hamburg-American Line at Hoboken, N. J. Following this session a special train will take those desiring to make the excursion to the new Henry R. Worthington Hydraulic Works at Harrison, N. J. Wednesday evening there will be an illustrated lecture at 44 West 27th Street by Prof. R. W. Wood of Johns Hopkins University on Photography of Invisible Phenomena. The third session will be on Thursday morning at 44 West 27th Street and besides the presentation of professional papers there will be a discussion on the subject of "Bearings."

Thursday afternoon there will be a reception at the New York School of Automobile Engineers, 146 West 56th Street. The usual reception at Sherry's will occur on Thursday evening. The closing session will be at 44 West 27th Street on Friday morning and will be devoted to the presentation of professional papers.

Fig. 4. Head Frame at Mouth of Water Hoist Shaft

NEW SHOP OF THE HOEFER MANUFACTURING COMPANY.

In the accompanying cuts and specifications we present the new shop of the Hoefer Mfg. Co., of Freeport, Ill., as an excellent example of the slow-burning mill construction type of machine shop building adapted for a moderate size manufacturing plant employing, say, 60 to 100 men. The concern was established in 1892 as the Stover Novelty Works with a capital of $3,500, and in 1899 it was incorporated under the present name with a capital of $36,000. After the making of novelties was discontinued, the manufacture of machine tools and special machinery caused a rapid growth of the business and made necessary the new quarters now occupied. The structure, which was completed in December, 1904, at a cost of $22,000, is a three-story brick building, 60 x 120 feet, with a one-story ell at the rear for the heating boiler, blacksmith shop, japanning department, etc. The shop was built for the manufacture of upright drills and other light machine tools, wire straighteners, spring coilers and special wire-working machinery, and is a notably well-built, substantial and solid structure.

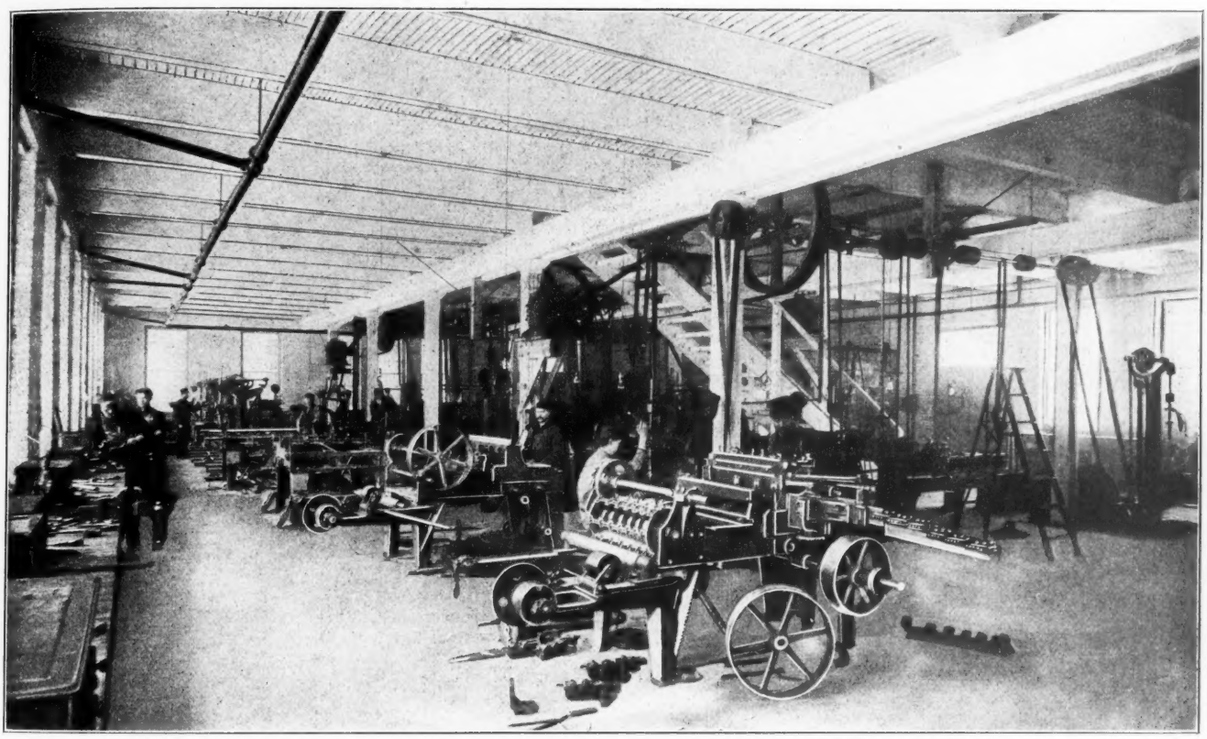


Fig. 1. First Floor Scene in Hoefer Mfg. Co.'s Shop.

As the structural details are the principal features of interest to be discussed in this article, we will give but a brief account of the mechanical and other features of interest, and conclude with the general specifications which, with the line cuts, nearly complete the data in this respect.

On the first floor are located the offices and general machine shop. On the second and third floors are the light machine shops where the drills and wire-working machinery and other special machinery is built. General views of the first and second floors are shown in Figs. 1 and 2. The shop has no machine power plant, the machinery being driven by Westinghouse two-phase constant-speed induction motors which derive current from the Freeport Railway, Light & Power Co. The current comes to the building at a voltage of 2,200 where it is reduced by stationary transformers to 208 volts. The machinery is arranged in groups and the lineshafts are run crosswise of the building, instead of longitudinally as is the usual practice. None of the lineshafts are longer than 22 feet and each is in one piece, and in no case are they supported by more than three hangers. There are ten lineshafts representing ten groups of machines, each driven by a motor and operating a total of about 65 machines. Each motor has a starting-box having three steps besides the "on" and "off" positions. The arrangement is one that is flexible and quite free from friction losses, for there are no long lineshafts, each shaft being comparatively short and supported so that it should easily be kept in perfect alignment.

An interesting and economical feature of the building is the heating plant. The boiler is erected in the cemented basement of the "ell." The radiators for the lower floor are 1¼-inch pipe coils, which are placed back of the work benches close to the outer walls. The workbenches are not placed directly against the wall, but an open space 6 inches wide is left, through which the warm air from the radiators rises up by the windows to the ceiling, from whence it is deflected to the center of the shop down to the floor and back under the workbenches. It has been demonstrated that there is a free circulation of the air currents in substantially the route described; the smoke of burning waste placed 10 or 15 feet away from the workbenches was drawn under them and upwards along the outer wall to the ceiling and thence downward. The second and third floors are supplied with cast-iron radiators 34 inches high, also placed beneath the workbenches. It will be remembered that the winter of 1904-5 was extremely cold, and although this building represents exterior radiating surface of 12,500 square feet, besides the roof and "ell," it was always comfortable, even when the mercury settled to 20 to 28 degrees below zero. The heat was uniformly distributed and often it was necessary to turn off some of the radiators, even during the coldest days. About 50 tons of coal sufficed for the winter, starting December 1. From two carloads, costing $190, at least 10 tons were left over.

The workbenches are made with a top of 2-inch matched plank running lengthwise and covered by ⅞ x 3-inch maple, running crosswise. A 4-inch rail or guard is placed on top of the bench in rear to prevent tools and material falling off, and a 6-inch apron is provided beneath in front, to stop the heat from the pipe coils coming out against the workman's body. The tendency of the circulation, however, is away from the workman up between the workbench and the outer wall, making the benches very comfortable to work in front of during all kinds of weather.

In making allusion to the product of the concern, mention was made of special wire machinery. Some of this product is of an exceedingly interesting character. The machine shown in the foreground of Fig. 3 is for making a spring bed fabric composed of "wish-bone" shaped pieces of wire, which are automatically formed in the machine, at the right, and distributed along the apron in front, where two operators hook them in place to form the fabric. Wire coiling machines for making open and closed springs, both cylindrical and other shapes, are made. One type of spring-coiling machine makes the coils used on stove lifters, pokers, etc., the coil being larger in the center than at the ends. Obviously such coils can not be wound on a mandrel. This machine employs no mandrel for making any shape of springs, and the mechanism being independently adjustable for lead, shape and diameter of the helix, it comes close to being universal in application to all shapes of springs within its capacity.

by scale. Anything which is not shown on the drawings, but which is mentioned in the specification, or *vice versa*, or anything not expressly set forth in either, but which is reasonably applied, shall be furnished and performed the same as though specially shown and mentioned in both. Should anything be omitted from the drawings or specifications which is necessary to a clear understanding of the work, or should any error appear either in the various instruments furnished or in the work done by other contractors affecting the work included in this specification, it shall be the duty of the contractor to notify the owner. In the event of contractor failing to give such notice he shall make good any damage to or defect in his work caused thereby.

ALTERATIONS.—Should the owner at any time during the progress of the work request any alterations to or deviations or omissions from the work included in the specification, such request shall be acceded to by the contractor and the same shall in no way affect or make void the contract. No such alterations, additions, deviations, or omissions which affect the price or the time for completion as agreed upon shall be done, however, without a written order from the owner.

CARE OF BUILDING.—The contractor is to have full charge of the building until completed, and he will be held responsible for all property that may be injured or stolen while the building is in his care.

OTHER CONTRACTORS.—Contractors for work not herein included shall be admitted to the building to perform their work at such times as the architect may deem for the best interests of the work, but they shall be responsible to the general contractor for whatever amount the owner shall adjudge they have damaged his work.

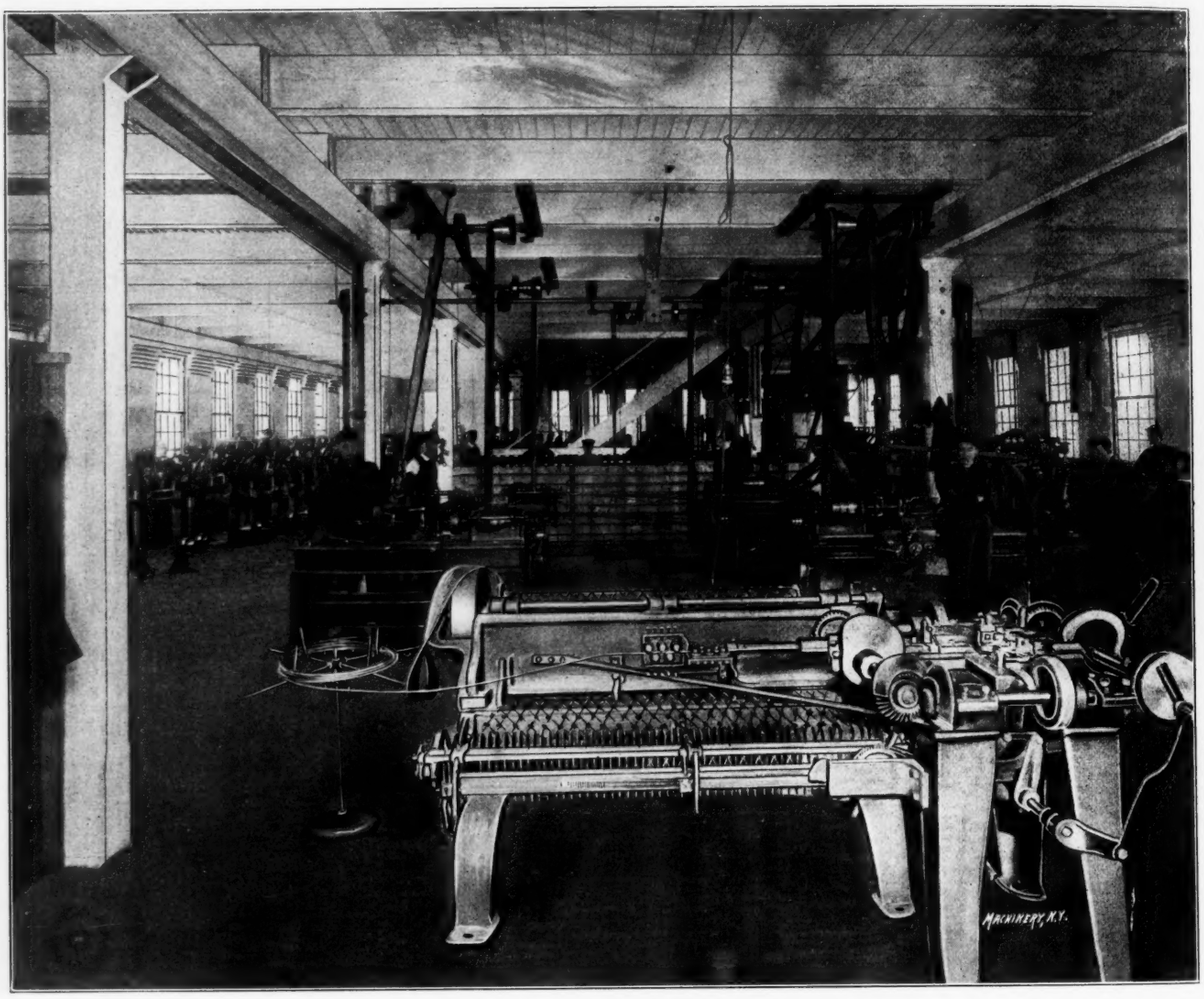


Fig. 2. Second Floor View showing Example of Special Wire Forming Machine in Foreground.

Specifications for the Stone and Brick Work.

GENERAL CONDITIONS.—The contractor shall furnish all material, labor, transportation, scaffolding, utensils, and so forth of every description required for the full performance of the work herein specified, except as otherwise particularly mentioned. He shall lay out his work and be responsible for its correctness; shall keep a competent foreman on the premises; shall obtain all necessary permits to properly carry out his work, paying the lawful fees therefor; shall give to the proper authorities all requisite notices relating to the work in his charge; shall afford the architect every facility for inspection; shall be responsible for all violations of law or damage to property caused by him or his employes and shall properly protect his work during progress.

WORK AND MATERIAL.—All materials are to be of the best of their kind in quality as herein specified; all labor to be performed in the best manner by skilled workmen, and both to be subject to the approval of the owner. All work and material must conform to the laws, rules and regulations in force in the locality in which the building is to stand, anything hereinafter specified to the contrary notwithstanding.

DRAWINGS.—The drawings referred to in this specification will be supplemented by detailed drawings to be furnished as the work progresses. All these drawings are intended to co-operate with and form a part of the specification and the accompanying contract. Where figures are given they are to be followed in preference to measurement

INSURANCE.—The owner shall insure the building and the material on the premises, covering his own and the contractor's interests therein against loss or damage by fire, such policies being made payable to the owner and contractor as their interests may appear.

DESCRIPTION.—The building is to be a three-story brick 60 x 120 feet, with a one-story ell, 24 x 60 feet, and an elevator tower in the angle; building to be located on the corner of Chicago and Jackson Streets, Freeport, Ill.

TIME AND PENALTY.—This building must be turned over complete to the owner not later than October 15, 1904. For each day the building is not completed after this date this contractor shall pay the owner as liquidated damages, the sum of $10, and for each day the building is complete before the above date the owner will pay the contractor $3.

BIDS.—Bids for erection and completion of the mason work for the Hoefer Manufacturing Co.'s building to be handed to Mr. Fred Hoefer on or before ————. The right is reserved by the owner to reject any or all bids. The contractor is to hand in separate bid for all foundation, walls, pier footing, etc., to be made of concrete, instead of stone.

EXCAVATION.—Excavate for all footings according to plans. The dirt to be filled into the area occupied.

FOOTINGS.—The footings are to be constructed as shown on plans, and detail sections except in case the soil does not have sufficient bearing quality at the depth indicated, in which case the owner shall

be consulted and price for going to additional depth adjusted. The footings to be concrete, composed of Iola, Chicago AA, or Atlas Portland cement, mixed as follows: 1 part cement, 2 parts clean sharp sand, 5 parts crushed screened stone. The stones to pass through a 2½-inch ring. Use no more water than is necessary to cover materials. As soon as mixed, take it to the trenches and dump it in, then ram immediately with iron tampers until water rises to the top. The next layer must be put on before the preceding one becomes dry and the top be well wet before putting in a new layer. No stone work is to be begun until concrete has set for a day. Planks shall be firmly staked in place to hold the concrete unless trenches are accurately dug. All cement used in the work must be fresh, and kept perfectly dry until mixed. For footings under column, build plank posts and set accurately as regard to centers.

STONE WALLS.—Lay up all walls complete according to plans and elevations with large flat bedded, local lime stone. Select the stone above grade for two street sides, and lay in even courses. Point nearly all work as it proceeds on both sides. The bonding shall be thoroughly and carefully done by frequently rising through stones, especially at corners. Fill in all space with stone, chips, and mortar. Build to a line on both sides and point up.

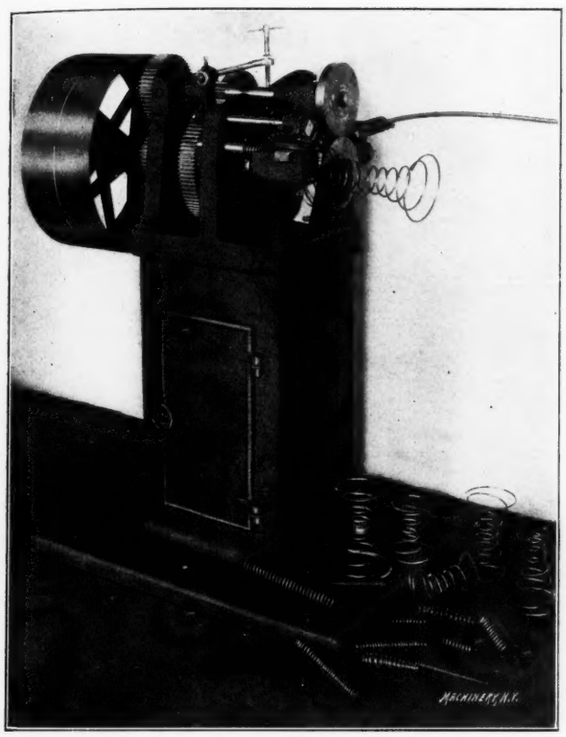


Fig. 3. Wire Coiling Machine built by Hoefer Mfg. Co.

MORTAR.—The mortar for stones to be composed of clean, sharp sand and fresh Portland cement of brands before named, and quantities 3 to 1 actual struck measure. All mortar to be mixed as it is used.

IRON WORK.—The contractor for the iron work shall set the iron base plates for posts, cast-iron angle guards, and all cast-iron sills shown on drawings.

WORKMANSHIP.—It is intended that the work shall be thorough and complete throughout.

Brick Work.

WALLS.—Lay up the walls as marked on plans with pilasters, etc., all complete. The face brick to be regular shaped, red sand brick, hard burned. The backing-up brick are to be Chicago building brick.

VAULT.—Vault to be constructed as per detail, surrounded by a shallow wall as follows: 9-inch brick, 3 inches air space, and 4-inch brick. Top to be covered with a double brick arch as shown, with five 1-inch rods running through as shown. Fill in above arch with sand to the under side of the second floor. Vault to have cement floor and to be plastered inside.

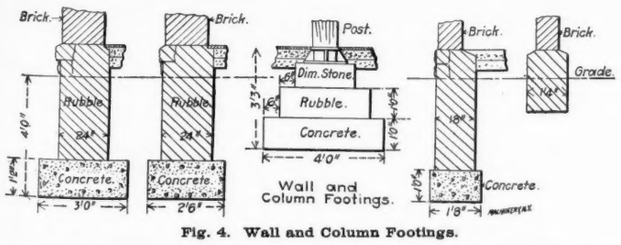


Fig. 4. Wall and Column Footings.

FLUES.—Build all flues as shown, smoothly plastered inside and from top to bottom. Start same near floor. Thimble to be located by superintendent. Soot drawer at bottom.

BOND.—Bond the walls with headers every seventh course—six course stretchers. Break bond for stretcher courses in interior wall. Lay up courses not to exceed 2¼ inches for joints in eight brick, laid dry. All joints to be neatly struck, both sides. The workmanship to be careful and accurate so as to make a true, plumb, and regular wall. Build three row-lock arches over window and four over doors, full thickness of wall. Window in third story and in annex to have double row-lock arches. Note detail showing means of support for joist at wall ends, also note that wall is corbelled between windows on second floor.

MORTAR.—The mortar is to be rich, well-tempered lime mortar, made of fresh lump-lime. Leave open about ½ inch around all large timber ends by inserting a board and removing same after wall is built. Lay up dry against all joists.

HEATING.—If any work is done in freezing weather, the sand, brick and water shall be warmed before using.

OTHER LABOR.—Masons shall accurately set all door and window sills, plates, etc. The mason shall assist the carpenter in setting door and window frames, and centers for arches furnished by carpenter. The mason is to see that the carpenter sets temporary supports under beams, etc., until masonry is set, also see that braces for frames do not interfere with work on first scaffold. All sills shown on drawings to be set by mason.

CUTTING AND FITTING.—The mason is to do promptly as directed all cutting and fitting that may be required in the mason work to make same come right with other work.

TERRA COTTA COPING.—Cover all fire walls where shown on one-story ell, elevator tower and main building with vitrified terra cotta coping laid solidly in cement mortar.

STONE COPING.—Lay stone coping on main building, 4 inches thick and in length not less than 24 inches of sawed blue Bedford stone. Same to slope back and have a drip. The chimneys to have a coping of 4 inches struck in one piece.

CLEANING DOWN.—In the course of the work, the mason shall remove his waste and refuse from the premises, when same is an obstruction or when so ordered by the superintendent.

CONCRETE UNDER FIRST FLOOR.—Under entire first floor of main building spread 4 inches clean steam boiler cinders; over these cinders lay 4 inches of concrete, in which imbed 2 x 3-inch strips level on 3-foot centers to receive 2-inch plank floor; on this lay ⅞-inch factory maple floor. Before spreading cinders, tamp the earth until level and solid and then tamp the cinders. The washroom and boiler room to have 4 inches of concrete over cinders; on top of this spread a finish coat ⅝-inch thick, mixed 1 to 1. This coat to be troweled smooth to make a finished floor; floor to slope to drain. Blacksmith shop is to have a floor same as main floor.

Plastering.

LATHING.—The ceilings of front office and private office, and all partitions around offices and store room to be covered with expanded metal lath. In the front office and in the private office and drawing

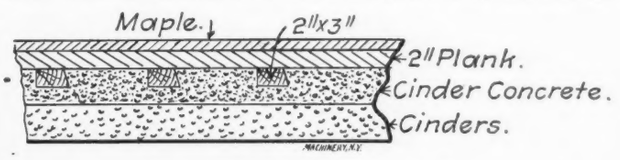


Fig. 5. Detail of First Floor Construction.

room the ceilings are to be furred down 12 inches below the joists to make an 11-foot ceiling in offices. Ceiling joists to be 2 x 8-inch spaced 16 inches on centers. The outside walls are to be furred lathed with wood lath and plastered. All surfaces to have three coats of Acme or Flint patent plaster, mixed according to directions of manufacturers. The last coat to be a hard finish mixed with fine screened sand in proportion, to make a smooth, hard job. Contractor shall furnish salamanders and dry out the plastering at his own expense. The offices and drawing room and office toilets are to have a patent plaster wainscot 3 feet 6 inches high all around, troweled to a smooth, hard surface.

Specifications for Carpentry and Mill Work.

TIME AND PENALTY.—Contractor shall begin work as soon after the letting of the contract as the mason's work will allow. He shall thereafter follow up the work of the mason as fast as possible, securing and setting frames as the mason is ready for them. The columns, joists, and girders to be on the ground and ready to set as the walls go up.

BIDS.—Bids for the erection and completion of carpentry and millwork painting, sheet-metal work, etc., to be handed to Mr. Fred Hoefer on or before ——————. Owner reserves the right to reject any or all bids.

CARPENTRY.—Sizes are all marked on plans. All timber shall be free from large loose knots, shakes, dry rot, or other defects that impair strength, that is, No. 1 is required. All posts over 8 inches to be bored 2 inches from end to end, twice across at top and bottom or as directed with 1-inch bore. Lay in 2-inch plank dressed for window stool for all windows as per detail. Do all framing whatsoever required to construct the building, and to complete the same in a workmanlike manner. Frame around stair opening and frame the

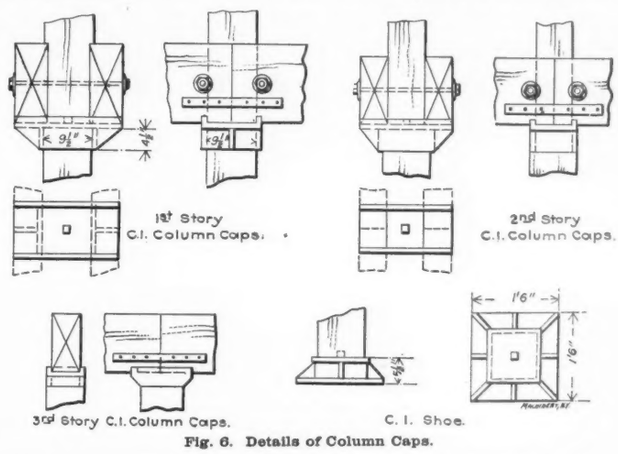


Fig. 6. Details of Column Caps.

roof girders and joists so as to shed the water away from fire walls. Furnish and set fifty-two ½-inch bolts, 22 inches long with washers to hold girders to column at first story ceiling, fifty-six ½-inch bolts with washers, 22 inches long to hold girders to columns at second story ceiling.

PLATFORMS.—Construct platforms and stairs running to third floor

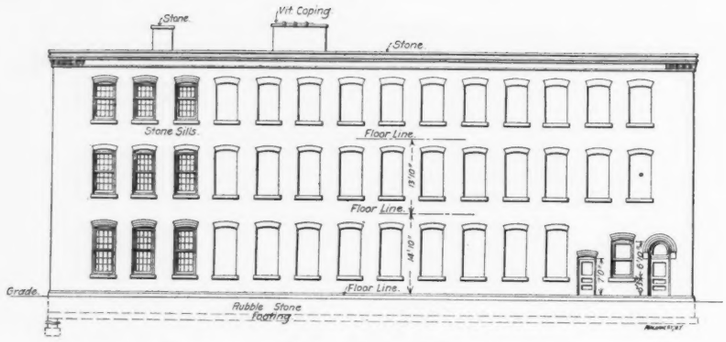


Fig. 7. Front Elevation.

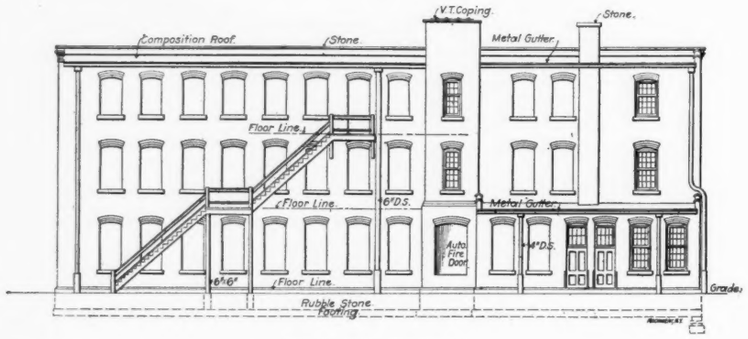


Fig. 8. Rear Elevation.

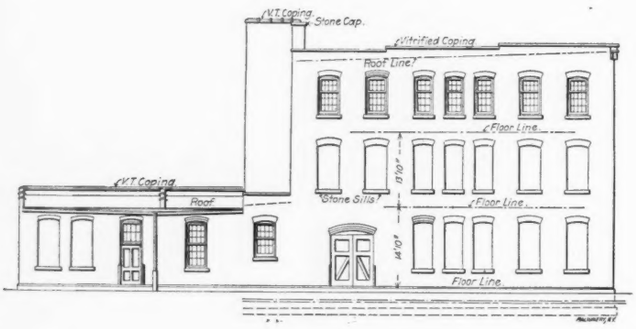


Fig. 9. Alley Elevation.

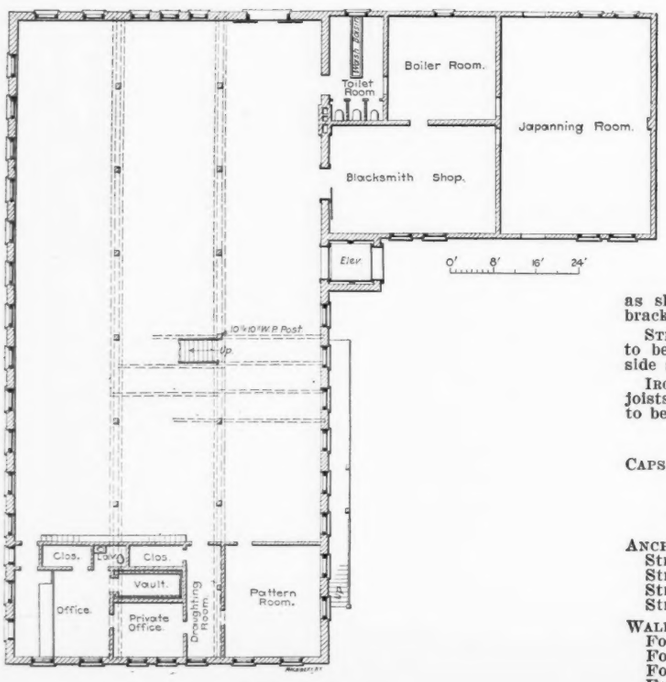


Fig. 10. First Floor Plan.

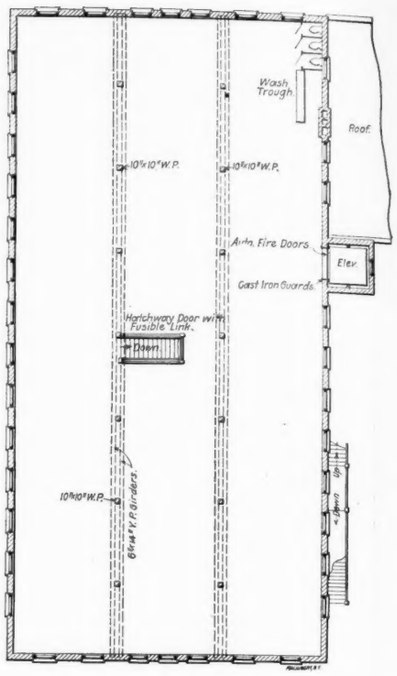


Fig. 11. Second Floor Plan.

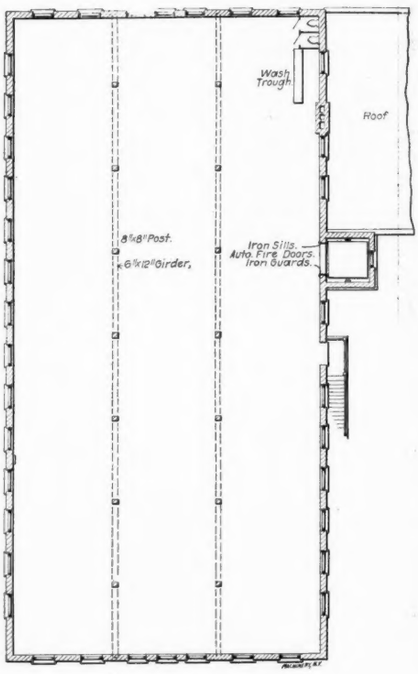


Fig. 12. Third Floor Plan.

as shown on drawings. Support landing on 6 x 6-inch posts and brackets.

STEPS.—Steps and ladders to be of 2-inch white pine. All parts to be dressed. Treads housed into strings and securely nailed, outside steps securely anchored to building.

IRON WORK.—All cast iron column shoes and caps, iron door sills, joists and girder-anchors, and angle-guards as shown and scheduled to be furnished by this contractor and to be set by him.

Schedule of Iron.

CAPS AND SHOES.—

Col. Shoes	14 Reg. as per detail.
1st story col. caps	13 Reg. as per detail.
2d story col. caps	14 Reg. as per detail.
3d story col. caps	14 Reg. as per detail.

ANCHORS.—

Strap anchors for girders, 1st story	26—2′ —0″ L—¼″x2″
Strap anchors for girders, 2d story	28″ —0″ L—¼″x2″
Strap anchors for girders, 3d story	28—20″ — ¼″ x 1½″
Strap anchors for roof joist over annex	10—16″—¼″—1½″

WALL ANCHORS.—

For 2 story floor joist and girder:	54— 16″ L—¼ x 1½—8″ bar.
For 3 story floor joist and girder:	54— 16″ L—¼ x 1½—8″ bar.
For roof floor joist and girder:	50— 16″ L—¼ x 1½—8″ bar.
For Annex roof	20— 16″ L.
Bolt anchors for outside stair	7— Required.

GUARDS.—
3 pair 3½′ x 3½ L guards 4′—0″ high with anchors.
3 pair C. I. jamb guards for 17″ wall 5′—0″ high with anchors.
2 pair C. I. jamb guards for 13″ wall 5′—0″ high with anchors.

VAULT DOORS.—One complete set of vault doors, 2 feet 4 inches wide furnished by owner.

MISCELLANEOUS.—Furnish all necessary anchors for doors, etc.

DOORS, TRACKS AND HANGERS.—All sliding doors shall be run on Coburn's sliding door tracks and hangers, of sufficient size and weight to carry each door, so it can be operated with ease. Carpenter shall drill holes into iron sill for door bolts.

FLOORS.—Construction of first floor as shown in masonry specifications, to be ⅞ inch thick, 2¼ inches face, best grade of factory maple nailed to 2-inch—5¼-inch face matched plank nailed to sleepers imbedded in concrete. The second floor to be composed of No. 2 3-inch white pine with 5¼-inch face, matched and beaded, dressed on under sides and spiked twice to each support. Lay over this floor the best grade ⅞-inch x 2¼-inch factory maple. Third floor, same construction except that under floor is 2 'nches thick instead of 3 inches.

CENTERS.—Carpenter shall furnish the mason with all necessary centers for arches.

ROOF.—Sheet all roofs with 1¾ x 8-inch No. 1 yellow pine matched and D. I. S. Make one scuttle in roof 24 x 30 inches with curbing ready for tinner, same to be secured with hooks and eyes. Build ladder of 1 x 3-inch dressed strips and secure to the wall as an approach to this scuttle way.

PARTITIONS.—Partitions around offices and drafting room to be 4-inch studding; partitions to be lathed and plastered both sides, as specified in plaster specifications. Partition for pattern room to be ⅞-inch x 3¼-inch face yellow pine matched and beaded.

WINDOW FRAMES.—Construct the window frames according to details of 1¾-inch white pine free from sap, shakes and knots. Frames throughout the building, except windows in office, to have plank frames with stops so sash can slide. Office windows to have box frames. Pulley stiles ⅞-inch, sills 1¾-inch. Sash cord No. 8 solid braided. Pulleys, 2¼ inches diameter. Iron weights to evenly balance same. Glass for all windows, except office windows, to be best single strength. The sash of office windows to be D. S. A. Office doors and employes' entrance to have plate glass. Mill man shall furnish all frames with cross braces at centers and diagonal braces from corner to corner.

SASH.—All sash to be perfectly sound and dry No. 1 white pine 1⅜-inch check rail sash of proper size to be fitted tight and yet slide easily. Sash to have single strength glass, bradded, puttied and with one-third white lead. No sash accepted where putty has run.

DOOR FRAMES.—Make door frames according to detail of sound white pine. Anchor the jambs to brick work. The shop doors to be C. Select according to detail and elevations. All the office doors, doors to third floor and toilet rooms to be 5-panel or sash of No. 2 white pine, 1¾-inch. Small toilet room door to be 1⅜-inch. All doors must be thoroughly dry before putting together to avoid warping and shrinking.

STAIRS.—The stairs from first to second story to be of 3 x 14-inch yellow pine with yellow pine plank treads, housed into strings with ¾-inch risers. In second story a hand rail of 2 x 4 inches with 4 x 4-inch posts to encircle openings except in front. At head of stairs on second story floor construct a hatchway door of two thicknesses of ⅞-inch material, covered both sides with tin, and fastened so as to act with fusible link. Steps to third floor same as first to second.

PLUMBING AND CARPENTRY.—Do all carpentry work in connection with plumbing and heating.

SHEET METAL.—Prepare proper foundations for sheet metal work as shown or directed with look-outs and overhangs to the satisfaction of sheet metal work sub-contractor.

Office Finish.

GROUNDS.—Put on ¾-inch grounds for casings, wainscot cap, etc., where required.

CASINGS.—Case all openings and make all door and window jambs, miter casings, and lintels of yellow pine, according to details.

WAINSCOT CAP.—Run a wainscot cap around top of patent plaster wainscot, as shown on detail.

PICTURE MOULD.—Nail up firmly a ⅞ x 2-inch picture moulding in two office rooms. Run 8 inch base around office rooms.

HARDWARE.—Furnish and fix all hardware required to complete the building.

LOCKS.—Front doors to office and employes' entrance doors to have store door cylinder locks. Doors to third floor to have imitation bronze three tumbler store door locks. All large doors to have heavy wrought iron fasteners. Doors to boiler room and blacksmith shop to have heavy wrought iron thumb latch. All office windows to have sash locks. All other sash to have window spring bolts. The sliding doors to be hung on Coburn or equal hangers. Bolt the track to the wall and the hangers to and through doors.

ELEVATOR DOORS.—All elevator openings to be equipped with Meeker automatic fire doors.

TOILET DOORS.—To have Ives door bolts.

BUTTS.—All swinging doors to have 1½-inch pair heavy japanned loose-pin butts. For double-acting doors use Bommer hinges. Office transoms to be hinged at top and to have lifter.

Sheet Metal Work.

GUTTERS AND LEADERS.—For the main part of building there will be 8 x 10-inch galvanized iron gutters firmly secured to roof with hangers. On first-story portion to be a 6 x 6-inch galvanized iron gutter. Down spouts to be 6-inch corrugated galvanized iron on main building; those on annex to be 4-inch corrugated galvanized iron. All iron to be No. 24. All leaders to be solidly secured full length 1-inch from brick wall with hangers every 8 feet, and to have basket strainers at the head.

SCUTTLE.—Tin the scuttle with Taylor's or Merchant's "Old Style" tin.

FIRE DOORS.—Cover fire doors where marked with tin having a 25-pound coating.

Painting.

PRIMING.—All frames and other mill work to receive one priming coat of lamp black lead and oil at the mill before delivery. This contractor to do all other painting at the building.

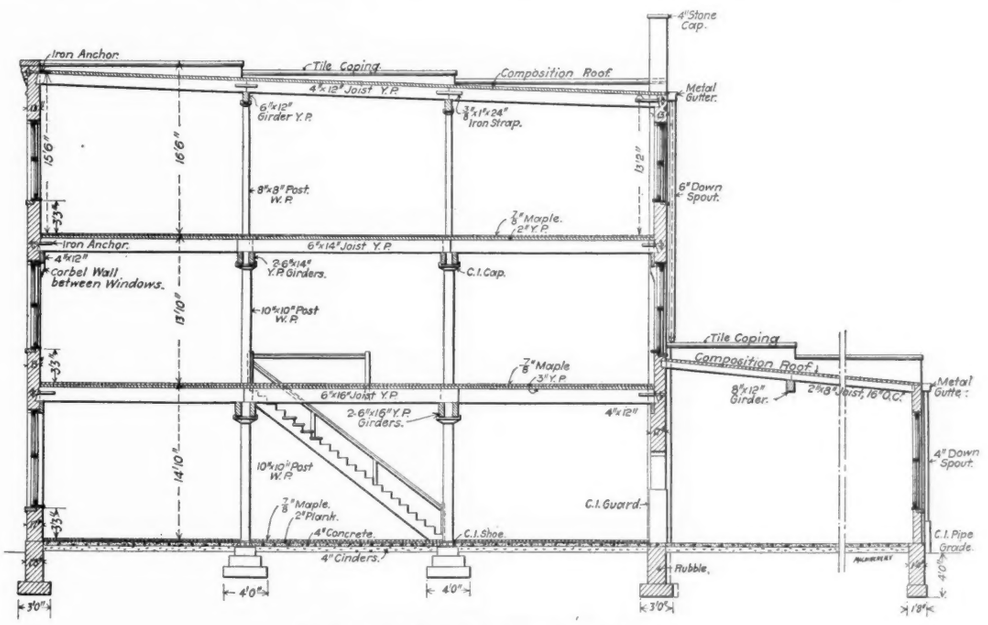


Fig. 13. Cross-section of Hoefer Mfg. Co.'s Shop.

EXTERIOR.—Shellac all knots and pitchy places. Prime all exterior woodwork and sheetmetal work with one coat ochre and oil, then putty up all nail holes, etc.

INTERIOR.—All interior finished woodwork of offices to be natural. Use one coat of Pratt & Lamber's surfacer with a little stain mixed with it to darken both the waite and yellow pine slightly, then apply two coats of "Pyramid" interior finish. The floors of office part to be given two coats of boiling-hot pure linseed oil. Paint the entire interior of the building one heavy coat of J. A. & W. Bird & Co.'s "Magnite Cold Water" white paint, or any other water paint equally good.

GRAVEL ROOF.—The entire roof is to be covered with tanned roofing felt, four-ply over one layer of dry felt. Each layer to have a solid continuous coat of hot pitch and tar composition 2 inches under second lap. Flash around scuttle and chimneys, firmly secured by solid nailing and re-mop. Mop the side brick wall to coping after felt is on. Same to be covered with hot composition thickly and evenly applied. In this there is to be embedded good screen gravel. This stone to be thoroughly clean. Composition is to be guaranteed not to crack with cold and not to run in hot weather, and to be acceptable to the superintendent, in quality. Entire roof to be guaranteed water-tight for 10 years.

* * *

The Quebec cantilever, now building over the St. Lawrence River, is to beat all the bridges in the world in having a single span of 1,800 feet. The Williamsburg suspension bridge over the East river has a span of 1,600 feet, only five feet greater than that of the Brooklyn bridge; and aside from suspension bridges, of which these are the greatest, there is the Forth railway bridge with two spans of 1,710 feet each. This new bridge at Quebec is the only one over the St. Lawrence River below Montreal, 130 nautical miles distant, and it will carry the Pacific coast trains of the Grand Trunk Railway from Moncton, N. B.

EARLY MECHANICAL HISTORY OF THE MERRIMAC VALLEY.

R. E. F.

It is a fact that must have been often noticed by any one who is given to reading biographical sketches of the members of the older generation of American mechanics, that a large number of them were born and reared and obtained their first start in the building of machinery, in that section of the country which includes the valleys of the Merrimac River and the upper part of the Connecticut. In a short trip which I recently took through this part of New England I had the good fortune to meet Mr. Chas. Hildreth, of Westford, Mass., a man whose memory goes back to the early days when machine shops were few and far between in this part of the world. His recollections are so clear and his description of the conditions which developed the abilities of our great mechanics are so interesting that it has seemed worth while to write down some of the facts which he gave me, adding thereto some information obtained from other sources.

It is hard for one of us, who is surrounded on every hand by complicated automatic machines and their products, to imagine himself living among the surroundings of an inhabitant of Central New England ninety years ago. Blacksmiths, wheelwrights and carpenters were the only mechanics. Some textile machinery was built, especially in the line of cotton spinning machinery, which had reached quite an advanced stage of development. There were scattered over Massachusetts and Southern New Hampshire rude furnaces where was produced the iron which went into the little machinery that was then built. These furnaces were fed with "bog iron ore" or low grade "stone ore" which the farmers dug from their own land and hauled into town, much as the market-gardener brings his produce to the city in this day. One of these old furnaces was located in the town of Chelmsford, Mass., and must have been running as early as 1673, for in that year under the date of February 3, there is in the town records the following statement: "the day above, by a Majer voatt was granted to farther the Iron works that they shall have for 2*d.* a cord leave to cut wood according to former agreement." A blast furnace was erected here in 1823 and was in continual operation until 1840. Then the scarcity of wood and the coming of the railroads made it unprofitable to run in competition with the Pennsylvania mines.

In 1824 Francis C. Lowell and others who were interested with him in the cotton mills of Waltham, came to the Pawtucket Falls in the Merrimac River in the town of Chelmsford, and there started the Merrimac Mills, the nucleus of the great cotton industry in this busy valley. Mr. Lowell introduced the power loom into America; it had been in use for some time in England, but there it was operated in strict secrecy and every precaution was taken to prevent the exporting of drawings or of the machines themselves to this country. Mr. Lowell had, however, seen them in operation and set himself to work at Waltham to build them for use here. While the machine that he built was intended to be a copy of the English machine, his acquaintance with that machine was so slight that the loom bore almost no resemblance to its prototype, and might almost be classed as a new invention. The first machine shop at the Pawtucket Falls in that part of the town of Chelmsford now known as Lowell, was started by Mr. Lowell and his associates for building the machinery for the new cotton mills. For several years this shop was thus engaged and then it was sold to the Proprietors of Locks and Canals, the company which controlled the water power of the river at this point. It was run under their management for nineteen years and in 1833 this shop with the other little establishments which had started in the town, were employing two hundred machinists and turning into machinery six hundred tons of iron in the course of a year's time. This is not a bad record for those days when wood was much more used in the manufacture of machinery than it is now.

In 1836 the Boston & Lowell Railroad was put through from Boston. Up to this time the traffic between Boston and Lowell had been carried on by the Middlesex Canal, the remains of which may still be seen by the traveler from the car window, following the railway "like a reproachful ghost." This canal was completed in 1804 and was the first important work of its kind in the country. Mr. Hildreth can remember when goods used to be brought from Boston over this canal to Lowell, transferred to flat boats and poled up the Merrimac River fifty miles to Concord. There were three falls to go around, one at Nashua, one at Manchester, and one at Hooksett, and canals had been built to make this possible. The coming of the railway of course put an end to all this.

George W. Whistler, the man who built the Boston and Lowell Railway, was born in 1800 at Ft. Wayne, Ind. He went to England when a young man and studied the business of railway building there, and on his return to this country built the New York, Providence & Boston Railway, the Boston and Lowell Railway and several others, besides laying out the water power improvements of Lowell in their present form. He died in 1849 at St. Petersburg where he had gone at the request of the Russian Emperor to commence railway building in that country. Under Mr. Whistler's directions there was built at the Lowell machine shop from a model engine he had imported from England, the locomotive equipment of the Boston & Lowell Railway. This is the only time that this shop has gone outside its field to build anything except textile machinery.

In the meantime the cotton industry had proved so profitable that mills had sprung up at various places along the river. The city of Lawrence was the seat of a large textile industry. Nashua, N. H., the next large town above Lowell, had invested a large amount of capital in the mills of the Nashua Mfg. Co. Many of these mills in these early days built their own machinery, and it is to these cotton mill machine shops that we must look for the beginnings of most of the great mechanics who were raised in this region. One of the Nashua Mfg. Co.'s workmen, John Gage, went into business for himself, and later took into partnership two of his workmen, Warner and Whitney by name, thus forming the firm of Gage, Warner, and Whitney of Nashua, N. H., which was, so far as is known, the first concern in this country to make a business of manufacturing machine tools. The old shop is still running in Nashua with many of the old tools, and is an interesting place to visit for any one who cares about the beginnings of the machinery which we are using in our shops to-day.

When the Nashua Mfg. Co. had finished the equipment of their mill it was sold to two of their employees, Ira and Ziba Gay, who are said to have come originally from Providence. They moved the plant down to North Chelmsford and bought from Captain Drake the old Chelmsford Iron Works, of which mention has been previously made. To the foundry which was connected with this iron works they added their assortment of machine tools, most of which they made themselves, and commenced the manufacture of woolen machinery. In February and March numbers of MACHINERY, Vol. III, year 1896, will be found a description of this old shop as it was running then under its name of Silver & Gay.

When they came to the North Chelmsford shop, the Gay brothers brought with them a man who played an important part in the evolution of the New England countrybred mechanic. This man was William E. Burke. He was born of an old family in Windsor, Vt., where he lived through his boyhood, going to the country schools and studying a year or so at the Windsor Academy. When fifteen years old his folks moved to Nashua and he started in to learn the business in the Nashua Machine shop. The Gay brothers brought him to North Chelmsford to act as their timekeeper. While here he attracted the attention of Mr. French, one of the Lowell mill owners, a man of broad education and generous nature. Mr. French took young Burke under his charge, gave him a home-made but liberal education, taught him all that was then known in the way of mathematics, machinery, and machine design, and finally got him a position as master mechanic of the machine shops which were being built for the Amoskeag corporation, who were putting up mills at the falls in Manchester.

On this young man of twenty-eight years devolved the task of fitting up this new machine shop, filling it with machinery at a time when machinery was crude and hard to obtain, and finding workmen at a time when there was no trained machinists' class to draw from as there is in these days. In this last particular he was very successful. To his shop there in

Manchester he gathered young men from all over New England, taking the young blacksmith from his cross roads forge, the wheelwright from his village shop, and the farmer boy from the corn field, and training them to become intelligent, enthusiastic workmen, many of whom in later years rose to positions of fame and responsibility.

William Bement, who founded the firm of Bement, Miles & Co., was one of these young men. He was a blacksmith in Peterboro, N. H., before he went to work in the Manchester shops. Hugh R. Garvin, the founder of the Garvin Machine Co., was another man who came under Mr. Burke's influence. Mr. Hildreth himself owes much to this trainer of young mechanics.

By the year 1845 work had slackened up at the machine shop in Lowell, so the Proprietors of Locks and Canals sold it to Abbott Lawrence and others, and the business took the name of the Lowell Machine Shop, under which it has ever since been run. At Mr. French's suggestion the management of the shop was turned over to Mr. Burke, who came down from Manchester for that purpose, and he continued as its superintendent until 1862, when he left to take an active interest in the cotton mills of the city. Later on, in the seventies, he was again connected with the shop in the capacity of Treasurer, and under his administration the Lowell machine shop became the greatest builder of textile machinery in the country. From 1879 until his resignation a few months ago Mr. Hildreth has been the superintendent.

What has been said about these shops at Lowell, Manchester and Nashua, applies equally well to other mill centers all over New England. The birth of the machine shop in this part of the country was in the repair shop of the cotton mill. F. C. Pratt learned his trade in the "Aldrich Shop" in Lowell just across the way from the Lowell Machine Shop; Amos Whitney, who afterwards became his business partner, started life in the repair shops of the Lawrence cotton mill; and as to how many more of these men there may be who started their lives in a like fashion I do not know, but the cotton mill repair shop was evidently a fertile field for the growth of the pioneer American mechanic.

* * *

THE "GLOBOID" WORM DRIVE.

ROBERT GRIMSHAW.

The cuts show a new drive which has had well deserved success in Germany, and for which is claimed not only 90 per cent of useful effect but that it preserves its efficiency during a longer time than either the ordinary worm or the spiral gear drive. As will be seen from the illustrations, there is a worm in connection with a worm-wheel, but instead of the teeth of the latter being immovable, each consists of a truncated cone turning loosely upon an axis radial to the worm-wheel. The worm is of the hour-glass type. The combination of the hour-glass worm and the rolling teeth is what accounts for the noiseless working observed and the small loss of efficiency experienced. The conical rolls are mounted on hardened steel pins. Screws, washers, and other small parts which would increase the cost and diminish the efficiency, are avoided. In proof of the high efficiency of these worms, the wheel can run down the worm, even when the latter is single-threaded. For this reason the maker claims that the drive is specially adapted to automobile service. There are made

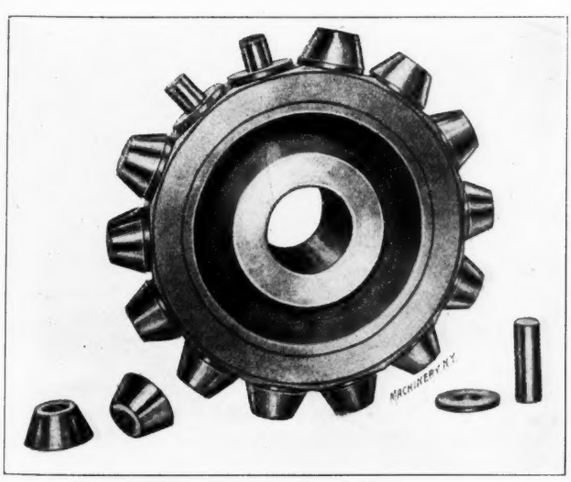


Fig. 1. "Globoid" Worm Drive, with Cover removed.

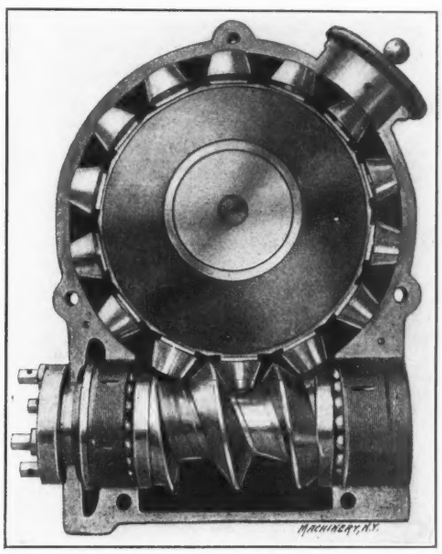


Fig. 2. Construction of the Wheel.

eleven different sizes of one of the types, with capacity up to 500 H. P. with 75 turns per minute of the worm-wheel and a velocity ratio of 10 to 1. In this case the turning moment on the wheel shaft is about 7,500 foot pounds. The velocity ratio can be anything from 2 : 1 up to 30 : 1, or with double reduction by means of two sets from 32 : 1 up to 1,000 : 1. As a rule the worms are single threaded, but there are cases, especially where the velocity ratio is below 8 : 1, where more

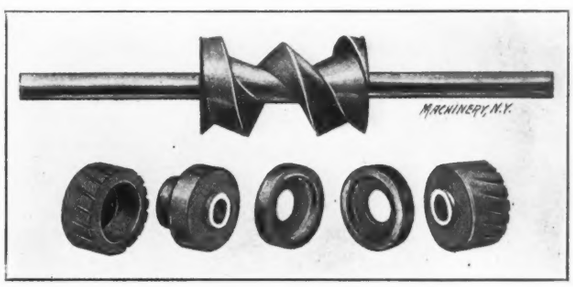


Fig. 3. The Worm and its Bearing.

threads are used. The entire casing is in two parts, as far as possible similar, bolted together so as to be oil- and dust-tight—a fact which very much facilitates the mounting and reduces the wear. Below the worm there is an oil chamber, in order to give the lubricant as much cooling surface as possible. The worms are of hardened and ground steel and run in phosphor-bronze boxes, while the end thrust is received by ball bearings. As these bearings are at both ends, the drive is adapted to both right-handed and left-handed connections. They also, as well as the cylindrical bearings, are adjustable, so that the worm can be adjusted axially.

The journals of the worm-wheel run in most cases in concentrically adjustable bearings, and their axial pressure is received by hardened and ground washers. The conical roller-teeth or tooth-rolls are of tough case-hardened cast steel, ground to the exact diameter. The rolls themselves are made of material selected for the particular service for which they are destined. It is claimed that with this style of toothed gear smaller diameters are practicable than in the case of the usual type. This, of course, means smaller casings and less weight. The maker is Hermann Pekrun, Coswig, Saxony.

TECHNICAL READING AND FORMULAS.—3.

C. F. BLAKE.

GRAPHICS.

The reader of technical literature will often encounter problems solved by what are known as graphical methods. All arithmetical calculations may be represented by drawings, and this is precisely what the many charts seen in the technical papers are, drawings of formulas.

To draw a formula we must first be able to draw the four arithmetical processes, addition, subtraction, multiplication, and division.

Addition.—Let it be required to add graphically 2 and 3, that is, to draw, the formula $x = 2 + 3$ and find the value of x from the drawing. In Fig. 11 draw line *a-b* two inches long, then commencing at *b* draw line *b-c* three inches long, which

Fig. 11.

shall be a continuation of line *a-b*. Line *a-c* now measures five inches, therefore $x = 5$, and *a-c* is the drawing of the formula.

Subtraction.—It is evident that subtraction will be the reverse of addition. Let it be required to draw the formula $x = 5 - 2$. Using the same figure as above, draw line *a-c* five inches long, and from one end, *a*, lay off *a-b* two inches long. Then *b-c* measures three inches, and $x = 3$, and *a-c* is the drawing of the formula.

The unit of measurement, here taken as the inch, may be any length convenient so long as all measurements are made to the same unit.

The drawing of the addition and subtraction formula as given above applies only to its individual problem, and since the number of problems is infinite, and even within the range of every-day practice is very great, some form of drawing which may be used for a great number of problems, is needed. In Fig. 12 draw two lines at right angles, and draw the diagonal line at 45 degrees. Let the horizontal line represent one unit, from 0 to 1, and let the vertical line also represent one unit, but let this unit be that from 1 to 2. Then the horizontal and vertical lines will be of the same length. Mark the horizontal scale 0 to 1, the vertical scale 1 to 2, and the diagonal line 1.

If now we begin at 1 on the horizontal scale, and travel vertically to the diagonal line at *A*, we have gone one unit, and if from here we travel horizontally to the vertical scale, we will travel another unit, or two units altogether. Then the line 1-*A*-2 represents the drawing of the formula

$$x = 1 + 1,$$

but since the line has been bent from the form of a straight line, we are no longer able to measure anything to obtain the answer. We do not need to do this, however, since we land at the figure 2, which is the answer. The operation has been made plain by the full arrows marked +. The reverse operation, subtraction, is shown with dotted arrows marked —, and the line 2-*A*-1 is the drawing of the subtraction formula,

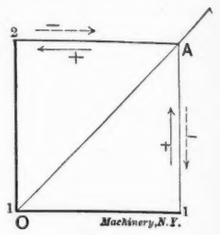


Fig. 12.

$$x = 2 - 1,$$

and beginning at 2 we end at the figure 1, which is the answer.

More diagonal lines may be drawn from points representing more units in the vertical direction, and thus we arrive at an addition and subtraction diagram, which may be made to cover any desired range of problems.

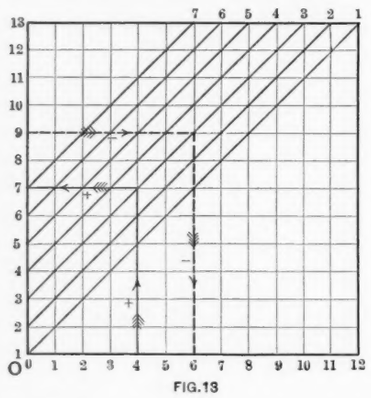


FIG.13

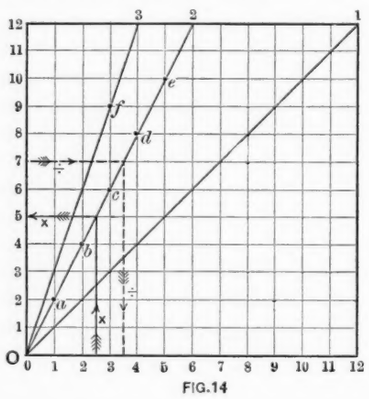


FIG.14

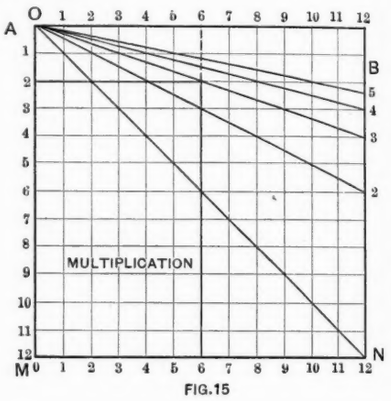


FIG.15

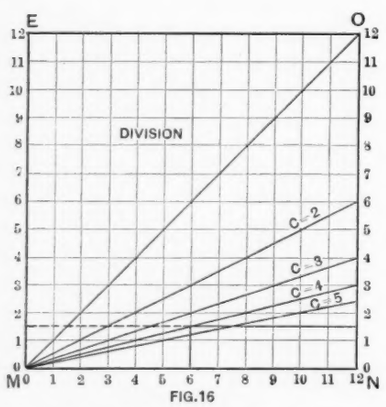


FIG.16

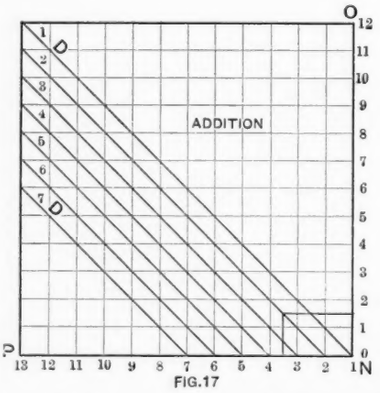


FIG.17

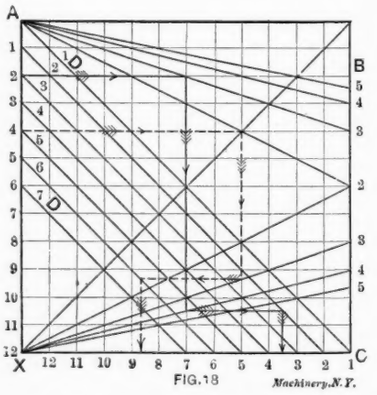


FIG.18

Fig. 13 represents such a diagram. The full line and arrows represent the problem,

$$4 + 3 = 7,$$

and the dotted line and arrows represent the problem

$$9 - 3 = 6.$$

Multiplication and Division.—A similar diagram to the above may be made for multiplication and division, as shown in Fig. 14.

Lay out the horizontal and vertical scales equal, each starting from the zero point (observe the difference between the two diagrams in this respect). Draw a 45-degree line from the zero point, and mark the line 1. If we start with either scale and travel to this diagonal line, and then to the other scale, we arrive at the same figure we started with, or in other

words, we have either multiplied or divided our starting figure by 1. Start now at 1 in the horizontal scale and travel vertically till opposite 2 in the vertical scale, marking this point *a*. Start again at 2 and travel till opposite 4, and mark the point *b*. Start at 3 and travel to 6, at 4 and travel to 8, and at 5 and travel to 10, marking the points *c*, *d*, and *e*. We now find that the points *a*, *b*, *c*, *d*, *e*, and the zero point are all in line; also that in starting at 2 and going to 4, etc., we have multiplied each of our starting points by 2. Draw a line through these points and mark it 2. Since the points are all in line, it is unnecessary to locate more than one to locate the line. Start at 3 and travel till opposite 9, and mark the point *f*. Connect *f* and 0, and mark the line 3, because $3 \times 3 = 9$, and we have multiplied our starting figure by three to locate *f* opposite 9. In this way as many other lines may be located as desired.

The full line marked $\times$ is the drawing of multiplication formula,

$$x = 2\tfrac{1}{2} \times 2 = 5,$$

and the dotted line marked $\div$ is the drawing of division formula,

$$x = \frac{7}{2} = 3\tfrac{1}{2}.$$

A set of such charts may be made for any formula, no matter how long, by making a chart for each step or arithmetical process in the formula. These separate charts may usually be combined into one with advantage. Figs. 15, 16, 17, and 18 represent such a series of charts and their final combination into one chart for the formula,

$$x = \frac{A\,B}{C} + D.$$

Let $A = 2$
$B = 3$
$C = 4$
$D = 2$

The first chart, Fig. 15, solves the first step, the multiplication of *A* and *B*. Values of *A* are first laid off vertically on the right, and at the top and bottom horizontal scales are laid off. The *B* lines are then drawn in, as in the previous multiplication chart, by assuming various values of *A* and *B*, and locating their proper points in the chart, as $A = 2$ and $B = 3$, $A \times B = 6$; through the intersection of lines from 2 and 6 draw 0-3, which is the line for $B = 3$. Draw lines for other values of *B* in the same manner. We find it possible to read the answer either at the top or bottom scale, and for the present we leave this question open.

The next step is to divide the product of *A* and *B* by *C*. In Fig. 16 lay off scale *M N* exactly like scale *M N* in Fig. 15. Lay off the two vertical scales, starting with zero at the bottom, otherwise exactly like the vertical scale in Fig. 15. Assume values for $A \times B$ and for *C* and lay off *C* lines as the *B* lines were laid off in Fig. 15.

We find we can read the answer either on the right or left, and leave the decision till later.

By multiplying *A* and *B* in the first chart, and dividing the product by *C* in the second chart, we have left only to add to the result, *D*, for the final step.

In Fig. 17 lay off scale *O N* exactly like *O N* in Fig. 16, and lay off scale *P N* exactly like scale *M N* in Fig. 15, but beginning with 1 at the right. Now draw an addition chart by assuming values for $A \times B \div C$, on scale *O N*, and values for *D*, and draw the *D* lines as described for the previous addition diagram.

By these three diagrams we can solve the equation,

$$x = \frac{A\,B}{C} + D,$$

if we have given values of *A*, *B*, *C*, and *D*. The process will be as follows: Find the value of *A* on scale *A M*, Fig. 15, and proceed horizontally to value of *B*, thence vertically, and read product of $A \times B$; find this product on scale *M N* in Fig. 16, proceed vertically to value of *C*, thence to right and read value of $A \times B \div C$; find this value on scale *O N*, Fig. 17, and trace to left to value of *D*, thence down to value of

$$\frac{A\,B}{C} + D = x$$

and read the answer.

It is a great inconvenience to have to jump from chart to chart, and it may be easily avoided. If these charts were drawn on tracing paper, and placed one over the other, we should find that their lines are all clear and distinct, and do not interfere with each other to the extent of losing their identity. This point was kept in mind when drawing the small charts; for example, in Fig. 16 the scales could be arranged so that the *C* lines would radiate from corner *E*, but they would then become confused with the *B* lines of Fig. 15 when the two are superposed; also in Fig. 17 the *D* lines could be drawn in the upper half by rearranging the scales, but they would then interfere with the *B* lines of Fig. 15 when superposed, while as drawn they appear in the opposite half of the chart from *B* lines, and they cross the *C* lines at such a great angle as not to become confused with them.

Fig. 18 shows the three charts drawn superposed one on another, and by inspection we see that it is no longer necessary to read the value of each step in order to take the next step, but that we can proceed from line to line, reading the value of each letter in turn, till we read the value of *x* at the bottom. The question left open as to which scales to read the answers on in Figs. 15 and 16 has solved itself in the superposed diagram.

The full line with arrows shows the working out of the same problem as the lines in the separate diagrams, namely, the value of *x* in the formula

$$x = \frac{A\,B}{C} + D$$

when $A = 2$, $B = 3$, $C = 4$, and $D = 2$.

Such problems as the following, and others, may be solved on this chart, and the reader should practice till he can solve such problems easily and quickly.

Shown in diagram in dotted lines.

$$\left.\begin{matrix} A = 4 \\ B = 2 \\ C = 3 \\ D = 6 \end{matrix}\right\} x = \frac{4 \times 2}{3} + 6 = 8.6$$

$$\left.\begin{matrix} A = 3 \\ B = 3 \\ C = 4 \\ D = 5 \end{matrix}\right\} x = \frac{3 \times 3}{4} + 5 = 7.25$$

It is in this manner that the charts we see in the technical journals, giving the strength of gears, shafts, etc., are worked out.

It often happens that it is necessary to vary the scales, also that in plotting out points, as *a*, *b*, *c*, etc., in Fig. 14, that the resulting line is a curve.

Such graphical processes as we have just been considering, and the laying out of charts is called graphical arithmetic. There is another branch of graphics called graphical statics, so frequently used as to demand a knowledge of its fundamental principles of any reader of technical publications.

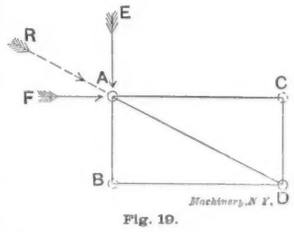


Fig. 19.

In Fig. 19 let *A* be a small ball, and let *E* be a force acting on the ball, and just sufficient to drive the ball to *B*. Also let *F* be a similar force just sufficient to drive the ball to *C*. If the force *E* acts alone the ball will start and travel *A-B* and come to rest at *B*, while if the force *F* acts alone the ball will travel *A-C*, and come to rest at *C*. Now, suppose that both forces act at the same instant. We would expect the ball to partake of motion resulting from each force, and to travel to the right at a distance *A-C*, and also to travel downward on the page a distance *A-B*, and this lands the ball at *D*. It cannot, however, travel either the path *A-C-D* or *A-B-D*, because it partakes instantly of motion from each force, and it can only travel *A-B* or *A-C* under the influence of one force acting alone. We will also assume that the ball must travel in a straight line, because to cause it to travel in a curved line we should have to introduce a third force in the shape of guides or other device, and we are supposing the ball to be acted on only by the forces *E* and *F*.

Therefore, since it must travel a straight line, must land at *D*, and cannot travel either *A-C* or *A-B*, it must travel *A-D*.

It is obvious that we could easily move the ball from *A* to *D* by a single force acting in the direction of *A-D*, and just strong enough to move the ball and bring it to rest at *D*. Such a force would be the force *R*, shown in dotted lines in Fig. 19. There are formulas involving the trigonometrical functions, by which, knowing the force and direction of both *E* and *F*, we may find *R*, but it is more simply done by the following method:

Adopt some convenient scale of force, as one inch equals ten pounds. Along *A-C* lay off by this scale the force *F;* that is, if *F* is fifteen pounds, make *A-C* one and a half inches for the above scale. Lay off on *A-B* the force *E* in the same manner and to the same scale. Now complete the parallelogram by drawing *B-D* parallel to *A-C*, and *C-D* parallel to *A-B*. This is called the parallelogram of forces. If, now, we measure *A-D* by the force scale adopted, we find *R*. Thus, if with the above scale, *A-D* measures two inches, then force *R* is twenty pounds.

This force *R* is called the resultant of forces *E* and *F*, and the latter are called the components of *R*. By a little study of the figure it will be seen that the problem may be worked backwards, or that a given force *R* may be divided into two other forces at will. This process we call the resolution of forces, and we say that any force may be resolved into its components.

Now, experiment proves that the same thing is true when the forces act at any angle, as in Fig. 20. Now, suppose the ball acted upon by three forces, *E*, *F*, and *G*, the latter being shown in dotted lines in Fig. 20, and being such a force as acting alone would move the ball from *A* to *H*. Now, we know that *E* and *F*, acting together, move the ball to *D*, for we can locate *D* by drawing the parallelogram of forces, *A-B-D-C*, and *A-D* will be the resultant of *E* and *F*. Now, since any two forces may be replaced by their resultant, we may consider that the ball is acted on by only two forces, *R* and *G*. We may now draw another parallelogram of forces for *G* and *R*, being *A-H-J-D*, and the final resting place of the ball acted upon by the three forces *E*, *F*, and *G* will be *J;* also *A-J* will be the resultant of the three forces *E*, *F*, and *G*.

The observant reader will notice that it is not necessary to draw the entire parallelogram of forces in order to locate the ball, or the magnitude or direction of the resultant. Thus, we could draw *A-C* parallel to *F*, *C-D* parallel and equal to *E*, and *D-J* parallel and equal to *G*, thus locating *J*. Then, drawing *J-A*, we would complete a polygon, *A-C-D-J*, called the polygon of forces, and *J-A* is called the closing line, because it completes or closes the polygon.

Let us now suppose that, instead of being moved by the three forces, the ball remains at rest, but is still acted upon by the three forces, *E*, *F*, and *G*. We then say that the ball is in equilibrium, and this can only be true when some force acts counter or opposite to the resultant of the three forces. Such a counter force is called a reaction, and is represented by *J-A*.

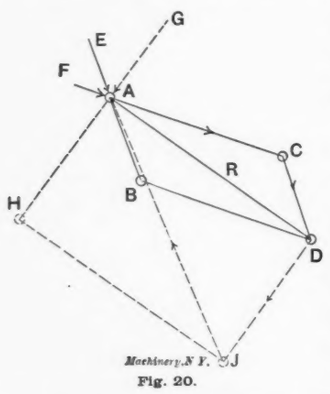


Fig. 20.

Let us now place upon each line, *A-C*, *C-D*, and *D-J*, an arrow corresponding to the forces *F*, *E*, and *G*, respectively, and we see that the arrows follow each other around the polygon; this must be so or the polygon is incorrectly drawn. Following this rule, and placing an arrow on *J-A*, we see the direction of the reaction that would keep the ball in equilibrium.

Since the three forces may be replaced by the resultant, *A-J*, and the reaction, *J-A*, keeps the ball at rest, we would expect: 1st, the line of the reaction to coincide with the line of the resultant; 2d, that the magnitude of the reaction and the resultant would be the same; 3d, that their directions would be opposite. This is precisely what the diagram shows because, 1st, the closing line of the polygon, *J-A*, has fallen upon the line of the resultant, *A-J*, of the three forces *E*, *F*, and *G;* 2d, the points *A* and *J* mark the ends of both the lines of the resultant and reaction; 3d, because the arrow placed upon the closing line in conformity with the other arrows points opposite to an arrow placed upon the line representing the direction of motion of the ball if no reaction were there.

The use of these principles of graphical statics may be well illustrated by the following example, Fig. 21. This represents a pulley or sheave, over which is passed a rope, on one end of which is a load, *L*, of 300 pounds. We know that, owing to the stiffness of the rope and the friction of the sheave pin, we must pull with more than 300 pounds on the other end of the rope in order to lift the load. Suppose we lose 10 per cent of our pull. We must then pull on the rope with a force, *P*, of 330 pounds to raise the load, *L*, of 300 pounds. Continue the lines of the rope to meet at *b*. Adopting a scale of 1 inch

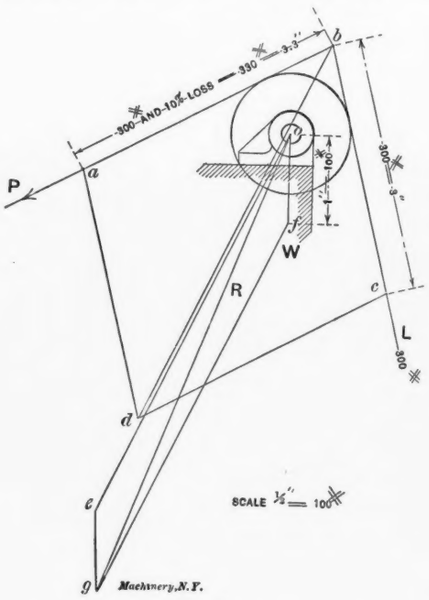


Fig. 21.

to 100 pounds, lay off *b-c* three inches long representing the load of 300 pounds, and *b-a* 3.3 inches long representing the pull of 330 pounds. Draw *c-d* parallel to *b-a*, and *a-d* parallel to *b-c*. Draw *b-d*, the resultant of *P* and *L*.

There is a third force acting on the sheave pin, namely, the weight of the sheave and rope, which we will call *W*. Let this weight be 100 pounds. From *o* lay off *o-e* parallel and equal to *b-d*, and in a vertical direction measure from *o* one inch, representing 100 pounds by our scale, locating point *f*. From *f* draw a line parallel to *o-e*, and from *e* draw a line parallel to *f*, thus locating point *g*. Then will *o-g* be the resultant, *R*, of the load and pull on the rope and the weight of the sheave, and the reaction of the support must be in this direction. Thus we know on which side to cap the bracket, to make the base, etc.

If we measure the line *o-g* we find it is 5.83 inches long, and multiplying by 100, since one inch equals 100 pounds, we find the resultant force on the sheave pin is 583 pounds.

If we had not taken account of the stiffness of the rope and friction of the pin, and had assumed the pull, *P*, equal to the load, *L*, which, of course, it is not, the line *b-d* would have passed through the center, *o*.

* * *

Apparently a new kind of machine tool has been discovered by an English contemporary, being, according to its designation, a turbine planing machine. It, however, resolves itself into a large Richards type traversing head planer built for heavy steam turbine construction. This machine built by Geo. Richards & Co., Broadheath, England, will plane 25 feet long, and across the top of work 10 feet wide and on the side of work 8 feet wide. It is driven by a 40 horse power motor. Its weight is 50 tons and it is specially designed for taking heavy cuts at high speeds.

NEW LIVERPOOL AUTO FIRE ENGINE WITH LIQUID FUEL SYSTEM.

FRANK C. PERKINS.

A motor fire engine is in operation in Liverpool which possesses some novel points of interest. It is fitted with a liquid fuel system of firing, known as Kermode's system, and was constructed from specifications of Chief Thomas, of the Liverpool fire brigade, by Messrs. Merryweather & Sons, Ltd., Greenwich, London.

The accompanying illustrations show the details of the liquid fuel burner and its connections with the boiler of the fire engine, as well as the arrangement of the piping and firebox. A pipe leads steam from the boiler to the burner, the steam being controlled by a valve and the pressure at the burner being indicated by the gage, which at full load reads about 33 pounds per square inch with a boiler pressure of 100 pounds. The oil is supplied through a lower pipe to the burner, which weighs less than 10 pounds and has an extreme length of less than a foot, one burner only being fitted to the firebox. The steam atomizes and heats the oil, driving it into the firebox along with a large amount of air, on about the same principle as an injector. The usual firebox has been deepened, a steel plate ⅛ inch in thickness being added with a lining of fire brick 1.5 inch in thickness. The bottom of the firebox is provided with a steel plate 5-16 inch in thickness in place of fire bars, this plate being drilled with holes ⅞ inch in diameter. The oil gravitates to the burner, although should it be necessary the burner by its action is capable of lifting the liquid fuel to a height of 24 inches.

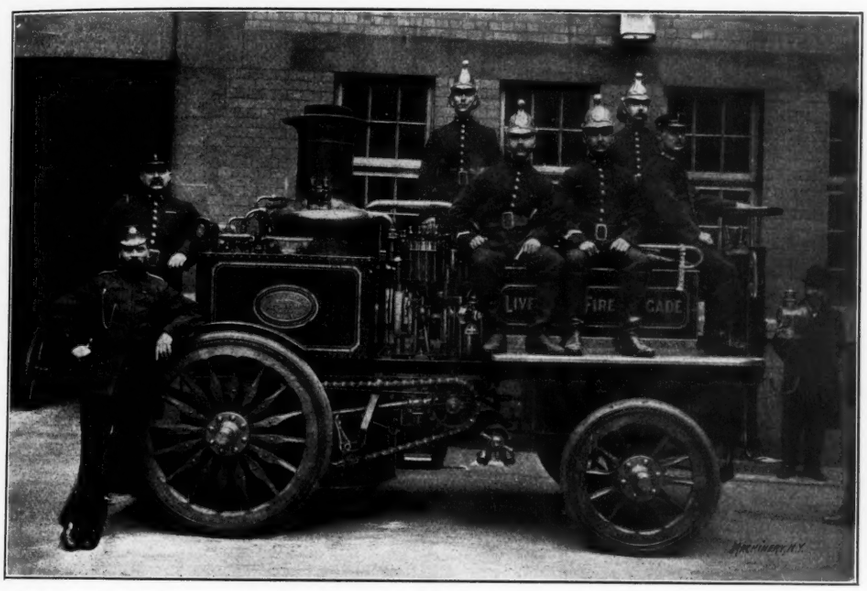


Fig. 1. The Liverpool Oil-burning Automobile Fire Engine.

The Liverpool self-propelled fire engine has a steam motor of 50 horse power capacity which may be used as a pumping engine or as a chemical engine, with a capacity for throwing 500 gallons per minute in from one to six streams over the highest buildings, and is fitted with a sixty-gallon chemical cylinder. It carries 1,500 feet of hose with the necessary attachments for water mains, together with a Pompier ladder for scaling high buildings. It also carries eight firemen and one officer and sufficient oil for operating the engine about five hours, both for propelling the vehicle and for steam-pumping purposes.

Two auto steam motor fire engines have been on constant duty with steam up for one and two years, respectively, and there is also in operation a horse-drawn portable air and electric light engine fitted with the Kermode burner, this outfit being kept constantly under steam. The dynamo is mounted on top of the vehicle and supplies current to a number of incandescent lamps fitted with handles and wire guards and connected to flexible cables of considerable length on reels.

While the fire engine is not in use a pressure of 80 pounds of steam is kept up by a gas burner in the firebox, and when a fire alarm is given the gas burner is withdrawn, the oil is supplied to the burner, and the fire engine is ready for service. By this arrangement 30 seconds only are necessary for the engine to start. It can easily make a speed of 20 miles per hour through the streets and thus reach the fire before the horse-drawn fire engines. It is claimed that no smoke is thrown from the stack nor fuel dropped on the way, and the engine has been in operation a number of months without the boiler tubes being cleaned or the burner requiring inspection.

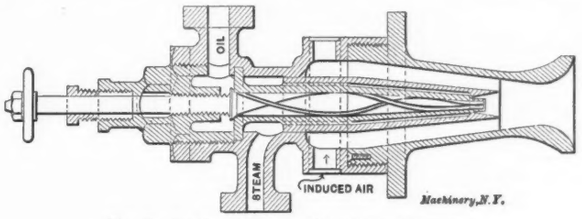


Fig. 2. Sectional View of Liquid Fuel Burner.

If it is found that the fire is of small dimensions, as three-fourths of the Liverpool fires are, the chemical engine is used, and the hose carried on the fire engine is employed. If, however, it is a serious fire, the pumping engine with six lines of hose attached is brought into service. By combining these various elements in one machine, therefore, one engine is capable of performing what formerly required three fire vehicles to accomplish.

For country fire stations this latest addition to fire brigade equipment ought to prove a boon, as the air or gas charge will last for any length of time, and when a fire call is made the charge is brought into operation at once and steam raised with oil fuel on the way to the fire. The entire absence of hand stoking allows the firemen to be engaged in the work of salvage in fighting the fire.

Oil fuel has many advantages over coal and wood for fire engine work, being clean and smokeless, with no sparks or soot deposit. It results also in even steaming, automatic stoking and economy in managing the engine, while the steam can be rapidly raised, lowered or stopped as desired, constituting an important feature. The failure of a feed pump or injector might result in a calamity where coal is used as fuel, but where liquid fuel is used the fire is under constant control. By the use of liquid fuel it is not necessary to reinforce the fuel supply of the engine, in the way in which it has heretofore been found needful with the coal fire engines, unless the fire is a very long and stubborn one.

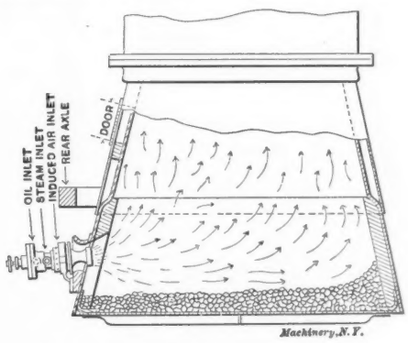


Fig. 3. Arrangement of Burner and Fire Box.

MILLING MACHINE FIXTURES.—2.

E. R. MARKHAM.

There are many pieces of work that can be machined at a much less cost if a fixture specially designed for the purpose is used. When the number of pieces to be done warrants the outlay, it is generally advisable to pursue this policy. There are other pieces of work that must be held in specially designed fixtures, in order to produce a sufficient degree of accuracy, and there are still others that cannot be machined unless such fixtures are provided. The design of such fixtures should always depend on the number of pieces to be machined, and the cost of doing the work. If a fixture is to be used for machining a relatively small number of pieces, then it should be made at as small a cost as possible. If, on the contrary, it is to be used as a permanent fixture for machining the same class of work for an indefinite period, then it should be made in a manner to insure its "standing the racket." Such fixtures should be made very strong and solid, as the cost for stock and labor is not much greater than when making a light, "shifty contraption."

As cast iron is the material used for the base of most fixtures of this kind, plenty of the material rightly distributed will insure freedom from chattering and uniformity of the product, provided other conditions are right. This additional weight of cast iron does not materially add to the cost of the fixture. As a rule cast iron does not prove satisfactory as a surface against which to bed small pieces when milling, and for this reason a surface of steel is generally provided for this purpose.

Fig. 11 shows a milling machine fixture used for milling a leaf for a Vernier rifle sight. It is necessary to have the sides *a a*, of the leaf parallel to the sides of the slot. The base, *b*, of the fixture is made of cast iron, the bottom of which is

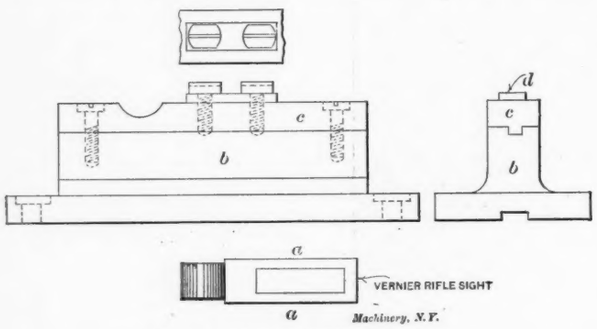


Fig. 11. Fixture for Milling Rifle Sight.

planed flat. It has a slot cut in it to receive the tongue pieces which fit a tongue slot in the table. A groove is cut in the top surface to receive a tongue on the steel portion, *c*. This is attached to the base by means of screws, after which the projection *d* is milled in the machine the fixture is to be used on. This insures perfect alignment between the sides of the tongue, *d*, and the table travel, and in consequence the sides of the leaf are exactly parallel to the walls of the slot when the pieces are milled. In the case of this particular piece of work it was found necessary to provide a somewhat complicated contrivance to hold the leaf down onto the fixture while milling, as the cut was rather heavy, compared with the strength of the sides of the leaf. But it occurred to us that by reversing the cutters and running them down onto the work, rather than against it, the cutters would be made to hold the work down onto the seating of fixture rather than to tend to raise it. All that was needed then was two screws, the heads of which screwed down onto the leaf. To release the leaf it was necessary to give the screw but a quarter turn as the opposite sides were cut away to a width a trifle less than the width of the slot in the leaf. The only reason it was necessary to provide the screws was that at the ends of the cut the pressure of the cutters tended to tip the leaf.

In order to produce good work when straddle-milling on a single-spindle milling machine, it is necessary to have the table travel exactly at right angles to the axis of the spindle. Should it not do so, it will be necessary to either scrape the saddle or swivel the head to get the alignment. The Lincoln type of miller usually has provision for the latter adjustment, but if not, and the saddle must be scraped, it is better to scrape the sliding surfaces which bear against the bed, instead of the table slides, unless the latter should be so badly worn as to need scraping.

The alignment of the saddle of a milling machine may be tested by means of a piece of wire attached to the spindle, as in Fig. 12. In this case the bearing surface to be tested is on a bevel, instead of standing vertical, and so a cast-iron block is planed to fit the angle portion, the block having a vertical surface for the point of the wire to bear against.

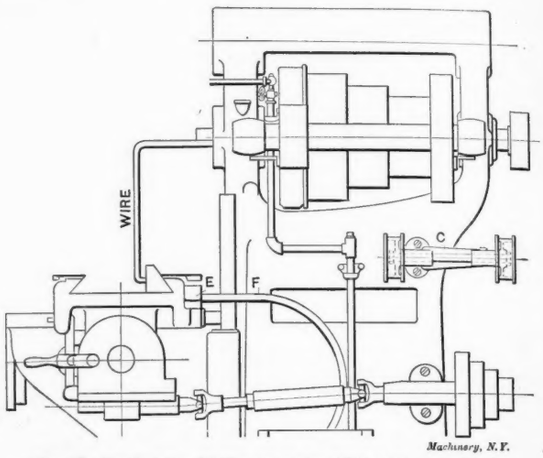


Fig. 12. Testing the Alignment of the Milling Machine Saddle.

Fixtures are many times made to hold two or more pieces of work to be machined at the same time, thus increasing the efficiency of the machine. Fig. 13 represents a fixture used in milling a bolt head flat on opposite sides. The fixture is designed to do away with any inaccuracy that might result from an attempt to mill bolts whose bodies were of varying sizes. For this reason the grooves for holding the bolts are made V-shaped instead of circular. The fixture is so designed as to allow the strain incident to cutting to come against the solid part of fixture. To insure ease of manipulation, the cam levers, used in clamping the pieces in the fixture, are located in the portion of fixture nearest the operator. Were they located on the opposite side it would be necessary to run the table back far enough to get the cam levers away from the cutters, so as not to endanger the operator's hands. Then again, if located nearer the cutters, they would be covered with chips, thus rendering it necessary to clean them every time before handling. The designer should always have

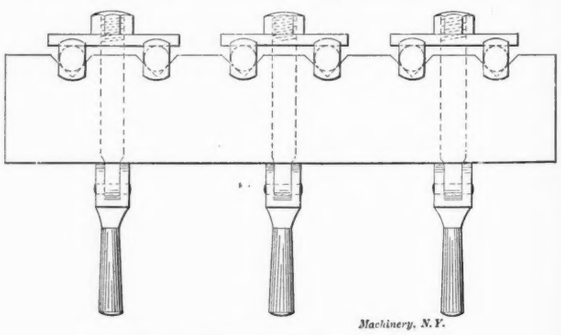


Fig. 13. Fixture for Flatting Bolt Heads.

in mind the safety of the operator, not only from a humanitarian standpoint, but also because accidents caused through poorly constructed tools and appliances are extremely costly to the manufacturing concern in whose shops they happen. I have known one such accident to cost a company more than all the tools they would make in a year, and a little forethought would have averted it.

It is generally better practice to have the device used in holding the piece of work to the fixture connected with that part which holds the work, as shown in Fig. 14. If this plan is adopted there is no danger of springing the fixture and

thus producing work which is not uniform to gage, as might happen if the design shown in Fig. 15 were used. If the fixture is extremely heavy and there is a certain amount of error allowable in the gaging, the objection to the method shown in Fig. 15 would not be readily apparent. However, for accurate work it is advisable when possible to adopt the method shown in Fig. 14, for it is possible to spring fixtures which are apparently quite strong.

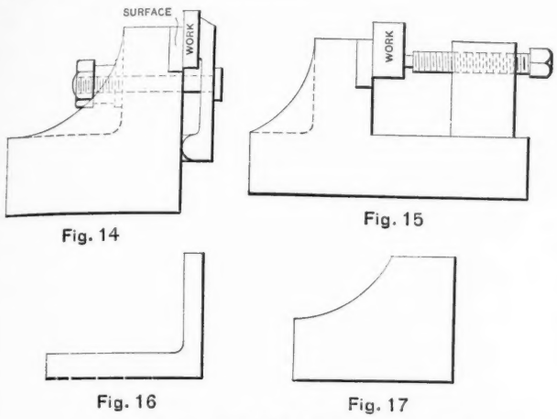


Fig. 14 Fig. 15

Fig. 16 Fig. 17

Points in the Holding of Work to Prevent Springing.

If a fixture is to be made in the form of an angle iron and considerable strain is to be exerted by the operation of cutting, the upright portion of fixture should be made heavy, so as to absorb vibration, and it should be well braced on back to prevent any tendency to yield under the strain. If such a fixture were made as shown in Fig. 16 the piece of work being machined would be chatter-marked from the vibration, and out of true from the yielding of the fixture. If it were made as shown in Fig. 17 neither of these troubles would be experienced, provided other conditions were right.

When possible always have the pressure of the cutter against the solid part of the fixture as shown in Fig. 18, rather than against the holding device, as in Fig. 19.

If you are called to design a fixture for holding work on a milling or other machine, bear in mind this fact: The simplest fixture that will hold the work in a satisfactory manner

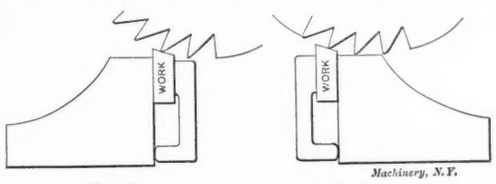


Fig. 18. Fig. 19.

Proper and Improper Direction of Cut.

is as a rule the most satisfactory, to say nothing of its lower cost. It is necessary at times, in order to accomplish a certain purpose, to make a complicated fixture, but the more complicated such a tool is the greater the probability of its getting out of alignment and out of working condition. There is a tendency on the part of many young designers to make elaborate fixtures, not realizing that true success in this branch of business depends on making all machines and tools in the simplest way possible. To be sure, most of the automatic machinery on the market is very complex in design, but the designer uses every effort to simplify where possible and still have it accomplish the desired result.

While it is absolutely necessary that milling machine fixtures be made in a manner that insures the desired degree of accuracy, yet they should be so designed that the work may be placed in and taken out in the shortest space of time possible, since this item adds very materially to the cost of the article. As it is customary to have the operator run several machines, the greater the length of time necessary to devote to one machine, the fewer machines he can tend.

So far as possible always work to, or by, a given surface, or other working point. Do not change and work from a different one unless compelled to do so, as any slight inaccuracy that in itself might be of little consequence might affect other vital portions. This same principle should apply to all machining operations.

As an example of what has just been written, let us consider the cutting plier jaw shown in Fig. 20. This jaw was first forged to shape from tool steel under a drop hammer. The side marked *a* was milled first, after which the opposite side was milled. Unless great care were taken when seating in the jaws the second side milled would not be parallel with the first. Now, this would not materially affect the finished jaw if one particular side were selected and worked to throughout the various milling operations. The surface *a* was selected as the working surface and was the one placed against the working surface of the drill jig. Then under normal conditions the drilled holes would be square with the surface worked from. The same side was also placed against the stationary jaw in milling machine vise when milling the surfaces *c* and *d*.

Then, if the jaws were properly made and set in the vise and reasonable care taken to prevent the presence of chips and dirt, the surfaces *c* and *d* would be square with *a*. The operations were afterward changed so the sides *a* and *b* were straddle-milled, but the first method of machining serves to illustrate the idea I wish to bring out.

A simple method I have used when necessary to mill a block perfectly square is to straddle-mill two sides as shown by hold-

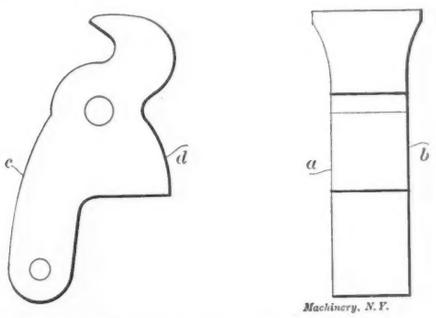


Fig. 20. Cuts taken in Finishing Drop Forged Jaw.

ing the block in the jaws of a milling machine vise. The other sides were straddle-milled also by holding the piece in the simple fixture, shown in Fig. 21, so designed that when the piece was fastened in the fixture, the tendency of the tightening device was to draw one of the sides that were milled at the first operation down onto the seating surface of the milling fixture as shown in Fig. 21. The tilting block *b*, bearing at the bottom tipped in such a manner when pressure was applied with the screw that it forced the work down onto the seating surface of fixture and back against the upright, etc. It might be found necessary when starting to use a fixture of this description to

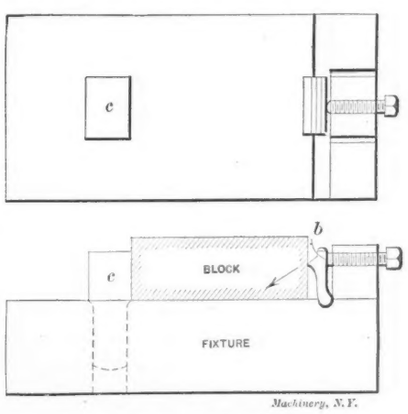


Fig. 21. Fixture for Straddle Milling.

block up under one edge with paper to bring the milled surfaces square with the seating surface, as the spindle and table of the machine might not stand exactly parallel. This must be ascertained by experiment. The parallelism of the two may be tested with a height indicator of the description shown in Fig. 22. However, if it is found necessary to raise or lower the machine the table may not stand in exactly the same relation to

the arbor as before moving. Then again the arbor may not be exactly true. All these things must be taken into account when testing machines for alignment.

I was engaged for a time in the manufacture of milling machines, and am free to confess that it is a problem, not always solved, to get a machine so trued up that it will show the same accuracy of alignment in one position as when the parts are raised or lowered or the saddle moved in or out. And an extensive experience in the production of work used in making guns, bicycles, knitting machines, and parts of machinery leads me to say that very few milling machines can be adjusted from one setting to another, and retain the same relative position of the various parts. To be sure they are correct enough for most

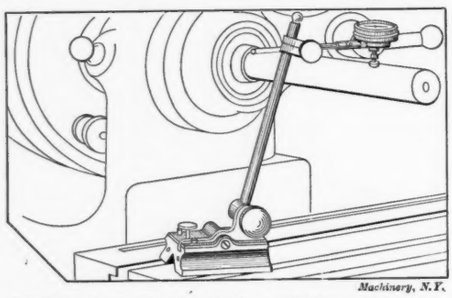


Fig. 22. Testing the Parallelism of Table and Spindle.

purposes, but when certain classes of work requiring an unusual degree of accuracy are to be done, it will be found necessary ofttimes to "shim" up under one edge of a fixture or else scrape a little stock from one portion of the seating surface, or in some way slightly alter the relative location of the arbor and seating surface.

Fig. 23 shows a bicycle hub having projections. Through these projections, or ears, are drilled holes to receive the spokes. Our equipment of milling machines was not sufficient to turn out the required number of pieces, and it was not deemed wise to increase our equipment, so we were compelled to devise ways of doing the additional amount of work on the machines we had. In order to accomplish this task, it was found necessary to make multiple fixtures.

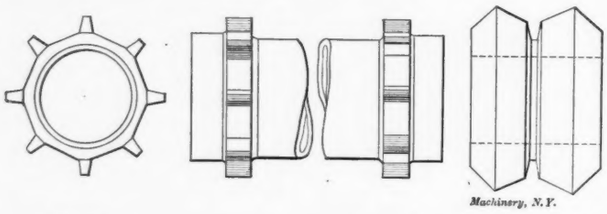


Fig. 23. Fig. 24.

A Bicycle Hub and the Cutter used in Making it.

Two fixtures were made to go side by side on a plate, each fixture to hold a hub. A dog was attached to one end of the hub, the tail of the dog entering an opening in plate on nose of spindle of the fixture. On the other end of the spindle was an index plate having around its circumference a number of holes equidistantly spaced, the number of which corresponded with the number of teeth to be milled on the hub. A hardened steel pin entered these holes and so located the hub. In making fixtures of this character where fine chips can get into the holes I have found it advisable to make locating holes straight rather than tapering, since when the holes are tapering there is a strong probability of fine particles getting in the holes on one side of the pin, thus causing the work to be unevenly spaced; but where the hole and pin are straight if the pin enters the hole, it must necessarily locate the spindle properly. If the holes and pins are properly ground and lapped, they will retain their size for a long time. In order to facilitate the pin entering the hole the end should be chamfered somewhat.

One thing that is sometimes overlooked is the inability of the cutter arbor to do the work without springing. Many times cutters are made with holes so small that the arbor cannot stand to the work without springing. If arbors are made for a special job and are to be subjected to great strain, they should be as short as possible. When milling the job shown in Fig. 23, it occurred to us that not only could we mill two hubs at a time, but we could also make each cutter able to mill the spaces between two teeth each time, making a cutter of the form shown in Fig. 24.

In Fig. 25 is a fixture that was used to mill a square on the end of an axle, but with the four sides slightly taper with the axis of the axle. On this account it was necessary to use an end mill rather than a face mill and in order to use an end mill in the ordinary milling machine, the fixture must hold the axle in a vertical position and with the axle standing at the right angle to produce the proper taper. It was found to be impossible to drill the spacing holes in the indexing dial of the fixture with sufficient accuracy by holding it between the

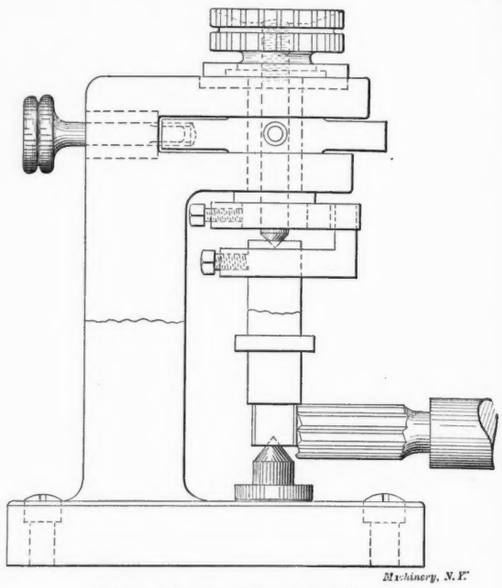


Fig. 25. Fixture for Squaring End of Axle.

centers of the dividing head when the holes were drilled on the universal milling machine, and we were obliged to resort to another scheme. A disk about six inches in diameter was placed between the centers of the universal milling machine and by means of an end mill was squared. When tested with a square, it was found that the sides were not exactly square with each other, however, and they were carefully scraped until they were as square as it seemed possible to get them. The disk was then placed on a stud located on an angle plate attached to the face plate of a lathe. The indexing dial we were to drill was then fastened to the squared disk and after locating one side of the latter parallel with the face plate, a hole was drilled and bored in the dial at the proper location, after which the stud was turned so the next side of the squared piece was parallel with the face plate. By continuing this method four holes were drilled and bored that were equidistant from each other. These holes were bushed with hardened steel bushings, ground inside and out-

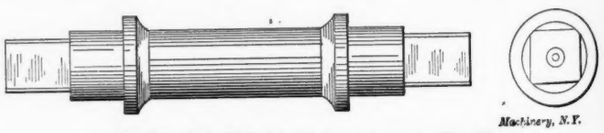


Fig. 26. Axle Milled in Fixture shown in Fig. 25.

side, and then forced into the holes. Pieces milled on this fixture and which were located by this dial were found so nearly square that no error could be detected when tested with a square. Fig. 26 represents the axle whose ends were milled.

The writer has attempted to avoid using complicated fixtures in illustrating the various methods of doing work, as they are so confusing, and the simple fixtures illustrate the methods involved as well.

There are certain principles which must be observed in designing fixtures of this character. These can be more plainly illustrated when simple fixtures are shown, but the designer may elaborate as much as is necessary to produce a tool adapted to the work in hand.

PROPORTIONS OF HAND TAPS IN SETS.

H. D.

In the October issue of MACHINERY I read an article, "The Proportions of Hand Taps" (in sets), which I thought was of great suggestive value, and I am greatly indebted to the contributor of the article in question for having so thoroughly treated this subject which I myself but lightly mentioned in my article, "Hand Taps with Standard Threads" in the July issue.

However, the contributor would have obtained a still better set of taps than the one he made if he had stopped to consider the point which he but lightly mentioned, viz., the diameter in the angle of the thread. No doubt he obtained a far better set of taps than those usually manufactured for the market, but he did not get the best set of taps obtainable. In order to accomplish this the taps should be made not only with a difference in the diameter on the top of the thread, but also with a difference in the angle diameter of the thread a considerable amount larger than what he mentions (0.001 to 0.002 inch).

Although the dimensions given in the article referred to for the different taps are well proportioned, if the taps are made without any difference in the angle diameter, it is obvious that as soon as a variation occurs in the angle of the thread the dimensions on the outside of the tap must necessarily be changed. For this reason I have laid out two diagrams showing the difference in the angle diameter for the various taps both for United States standard threads and for standard sharp V-threads, and have also shown by different shading how much each tap will be required to cut. The problem to consider is evidently a far more difficult one in this case, having two factors to contend with, viz., the difference in the outside diameter and the difference in the angle diameter. I consider the areas that each tap will remove, as stated in the article referred to, fairly well proportioned, even for taps made with a difference in the angle diameter. The only suggestion I would make is that the finishing tap be made in such a manner as to remove somewhat more than 1-16 of the total area of the thread.

According to the formulas given below, the proportion of the areas of the thread to be removed by each succeeding tap will be approximately as 6:3:1. Considering the matter in the same order as the former contributer, first considering the V-thread, and taking the pitch of the thread as the working factor, the distances from the top of the full thread to the top of the thread of the plug and taper taps respectively will be found according to the following formulas:

$$a = 0.15 \times \text{pitch.}$$
$$b = 0.47 \times \text{pitch.}$$

For the relative values of a and b see Fig. 1, showing diagram of the sharp V-thread. Again considering the difference in the

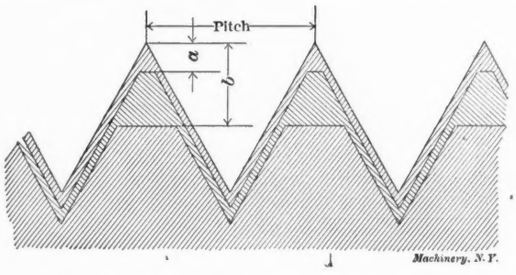


Fig. 1. Proportions of a Set of Taps for V Thread.

angle diameter of the thread, this ought to be an amount c and d respectively smaller than the correct angle diameter for the plug and taper taps.

For plug tap $c = 0.09 \times$ pitch.

For taper tap $d = 0.17 \times$ pitch.

For United States standard thread the formulas would be:

$$c = 0.05 \times \text{pitch.}$$
$$f = 0.33 \times \text{pitch.}$$

For the differences on the top of the thread (for the relative values of c and f see diagram, Fig. 2).

The angle diameter perhaps should, strictly considered, vary differently from that of a sharp V-thread, but the variation would be so slight that it can be eliminated in all practical considerations, and the variations between the correct angle diameter and that of the plug and taper tap can be made the same as for sharp V-thread, viz., 0.09 × pitch for the plug tap, and 0.17 × pitch for the taper tap.

For convenience, and in order to save the trouble of figuring the values from the formulas in each individual case, a table is given herewith, stating the amounts found from the formulas. The quantities a, b, e and f are given as $2a$, $2b$, $2e$ and $2f$, thus giving the differences for the diameter (a, b, e, and f being the difference on one side only).

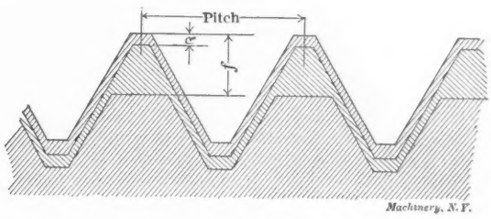


Fig. 2. Proportions of Set of Taps for U. S. S. Thread.

Only so many decimals are given as the writer considers necessary for all practical purposes. The same general arrangement of the table as used by the former contributor has been followed in order to make comparison easier. The differences in the angle diameters, although alike for United States standard thread and sharp V-thread has been repeated in both tables in order to secure uniformity.

No. of Threads per inch.	Pitch.	U. S. Standard Thread.				Standard Sharp V-thread.			
		$2f$	$2e$	d	c	$2b$	$2a$	d	c
3	.3333	.222	.033	.056	.030	.312	.100	.056	.030
3½	.2857	.190	.029	.048	.026	.269	.086	.048	.026
4	.2500	.167	.025	.042	.023	.235	.075	.042	.023
4½	.2222	.148	.022	.037	.020	.209	.067	.037	.020
5	.2000	.133	.020	.033	.018	.188	.060	.033	.018
5½	.1818	.121	.018	.030	.016	.171	.055	.030	.016
6	.1667	.111	.017	.028	.015	.157	.050	.028	.015
7	.1429	.095	.014	.024	.013	.134	.043	.024	.013
8	.1250	.083	.012	.021	.011	.118	.037	.021	.011
9	.1111	.074	.011	.018	.010	.104	.033	.018	.010
10	.1000	.067	.010	.017	.009	.094	.030	.017	.009
11	.0909	.061	.009	.015	.008	.085	.027	.015	.008
11½	.0870	.058	.009	.014	.008	.082	.026	.014	.008
12	.0833	.056	.008	.014	.008	.078	.025	.014	.008
13	.0769	.051	.008	.013	.007	.072	.023	.013	.007
14	.0714	.048	.007	.012	.006	.067	.021	.012	.006
16	.0625	.042	.006	.010	.006	.059	.019	.010	.006
18	.0556	.037	.0055	.009	.005	.052	.017	.009	.005
20	.0500	.033	.005	.008	.0045	.047	.015	.008	.0045
22	.0455	.030	.0045	.0075	.004	.043	.014	.0075	.004
24	.0417	.028	.004	.007	.004	.039	.0125	.007	.004
26	.0385	.026	.004	.0065	.0035	.036	.0115	.0065	.0035
27	.0370	.025	.0035	.006	.0035	.035	.011	.006	.0035
28	.0357	.024	.0035	.006	.003	.034	.0105	.006	.003
30	.0333	.022	.0035	.0055	.003	.031	.010	.0055	.003
32	.0312	.021	.003	.005	.003	.029	.0095	.005	.003
34	.0294	.020	.003	.005	.0025	.028	.009	.005	.0025
36	.0278	.019	.003	.0045	.0025	.026	.0085	.0045	.0025
38	.0263	.018	.0025	.0045	.0025	.025	.008	.0045	.0025
40	.0250	.017	.0025	.004	.0025	.0235	.0075	.004	.0025
42	.0238	.016	.0025	.004	.002	.0225	.007	.004	.002
44	.0227	.015	.0025	.004	.002	.0215	.0065	.004	.002
46	.0217	.0145	.002	.0035	.002	.0205	.0065	.0035	.002
48	.0208	.014	.002	.0035	.002	.0195	.006	.0035	.002
50	.0200	.0135	.002	.0035	.002	.019	.006	.0035	.002
52	.0192	.013	.002	.003	.0015	.018	.006	.003	.0015
54	.0185	.0125	.002	.003	.0015	.0175	.0055	.003	.0015
56	.0179	.012	.002	.003	.0015	.017	.0055	.003	.0015
58	.0172	.0115	.0015	.003	.0015	.016	.005	.003	.0015
60	.0167	.011	.0015	.003	.0015	.0155	.005	.003	.0015

The former contributor infers that taps of this description are not manufactured for the market at all. It is true that they are not generally manufactured in this manner, but the writer made a special study of this and kindred subjects at the St. Louis exposition last year, and although he found only one firm manufacturing taps in this way, it must be added to the credit of the manufacturers that at least one leading firm (Pratt & Whitney Co.) has not overlooked this important matter.

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MACHINERY

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DESIGN—CONSTRUCTION—OPERATION.

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PAID CIRCULATION FOR NOVEMBER, 1905,—22,317 COPIES.
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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a complete review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

It is not according to custom for the publishers of a mechanical journal to issue a holiday edition for the month of December, as in the case of the general magazines. On the face of it there do not appear to be very close ties between the daily routine work of the mechanic, with which a journal like MACHINERY has to deal, and the spirit of freedom and gaity that pervades the Christmas atmosphere. Yet, to how great an extent has mechanical science contributed to the season's enjoyment! How many gifts are made nowadays that the mechanic has not a hand in producing? How about the mechanical toy? The Christmas tree, lighted by incandescent lamps, is far safer than when illuminated by the incendiary candle; and it would seem that "Old Nick," arriving at the chimney top in an automobile, should render more efficient service than in days when he traveled in the historic sleigh. While MACHINERY shows no outward manifestation of the approaching holidays, it extends greetings to its many friends and believes that the mechanical work in which its readers are engaged contributes not a little to the pleasure of the Christmas season.

* * *

THE WORLD'S MARKETS.

Do American machinery manufacturers, as a body, realize how important foreign trade is to them? Of course those whose sales will be cut off by the impending increase in the German tariff fully realize its importance; but even those who cannot sell their product abroad are financially interested in creating and maintaining a market for other manufacturers who can, because whatever helps one helps all. A few years ago many American works were running to a great extent—as great as 75 per cent in some cases—on foreign orders; and the loss of that trade would have meant the closing of those shops. Such conditions may arise again, for this country cannot alone absorb all its manufactured product. The high protection duties which have benefited us in the past are no longer needful and should be modified; and reciprocal trade relations should be established with the great Continental nations that will keep their markets open to our manufacturers.

In a recent interview a leading German banker, speaking of the chances for a commercial treaty with his country, said: It is my opinion that slight concessions by the United States, say, in the import tariff on certain classes of articles imported from no country except Germany, and to no great extent even from that quarter, would satisfy the apparently unalterable position of Germany that a commercial treaty with your country must include some concession on your part. Granting that some such solution as I have suggested is found for this particular question, I think that all other questions involved could be settled to the mutual satisfaction of both countries.

It is to the interest of every manufacturer of machinery in the United States that the needful concessions be made.

* * *

INDUSTRIAL BETTERMENT.

One of the most interesting attempts at industrial betterment with which we are familiar is that of the Weston Electrical Instrument Co., Newark, N. J. They have not only made their factory a model of attractiveness and convenience for their employees, but have also established and turned over to their employees a club plant, a description of which appears in this number. They have attempted to eliminate entirely the element of paternalism which is objected to so strenuously by American workmen, by placing the administrative conduct of the club in the hands of their employees.

The establishment of harmonious relations between employer and employed and the elimination of discontent among the latter, through co-operation, is to be commended. There is, however, a diversity of opinion as to the best means of bringing this about and one prominent machine tool firm have expressed themselves in the following terse manner as opposed to many of the features that some other firms have found desirable:

We do not believe that it helps the man to give him something for nothing and we do not believe that he wants it. We have seen in a great many instances throughout the country where various plans of this kind have been tried, that the men rather resent it and come to look upon it as a charity which is not desired. We believe in giving a man a chance to earn his recreations, rather than provide them for him gratis, and we feel that all plans worked out on a basis of giving the man something for nothing are bound to fail, for the very reason that it can be nothing other than more or less of a charitable distribution and that the American workman is above anything of this nature.

It must be admitted that there is much to be said for this view of the situation. While we believe that every attempt to introduce social features in connection with factory life is made with an honest desire for co-operation, this action is often misunderstood and if such betterment features as are introduced were placed absolutely on a dollar-and-cent basis, some of the failures now met with in these efforts could be avoided. A manufacturer is entirely justified in introducing features that make the human part of the machinery of his plant more efficient; and while he may not at heart put it on that basis, it would perhaps be better to do so. More than this, from the fact that the manufacturer occupies a semi-public position, he is undoubtedly under *moral* obligations, at least, to make his plant, where his employees spend so many hours of their time, a healthful and comfortable place. This amply justifies the many improvements in the way of sanitation, safety appliances, ventilation, lunch rooms, etc., now provided by modern concerns. Beyond this, anything that can be introduced to improve the efficiency of his employees is justified. Whether, still beyond this, the social features, such as the Weston Company and others are introducing will accomplish their purpose can only be told in years to come.

* * *

MACHINERY has always made a feature of machine shop descriptions, and accounts of many of the best shops and shop buildings in the country have appeared in its columns. It is proposed now to extend the idea somewhat and give descriptions of several model shops of medium or small size, covering several types of construction. The first of these appears in this number in both the engineering and shop editions, and gives details and specifications of the mill-type building of the Hoefer Manufacturing Co., Freeport, Ill. In one or two other instances, also, specifications will be published and it is believed that the series of articles will be of much value to those investigating shop architecture.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

A new process of preserving wood is reported by Consul Atwell, of Roubaix, France, being treatment with sugar. It is said that specimens of soft wood treated by the Powell sugar process successfully withstand the ravages of white ants in tropical countries. It is thought that the new process will make a great change in the export timber trade to tropical countries as soft wood treated by it will replace the expensive teak and eucalyptus that are now necessarily used where white ants are a pest.

A recent report by Consul Mahin, of Nottingham, England, says that the German and English machine screw manufacturers have formed a screw trust and suggests that there are possibilities for profitable American competition. Heretofore a severe competition had prevailed between British and German manufacturers but when the syndicate was organized, prices were advanced 50 per cent and the market restricted. The British market will be closed to the importation of German screws and no British orders will be received by the German manufacturers after October.

It is commonly regarded as a desirable distinction to be the first man to cross a new bridge, to buy the first ticket sold on a new railroad, etc., but all "firsts" are not so desirable. The editor of the *Canadian Engineer* has been delving in railroad history to some extent and has dragged forth the fact that William Haskinson, a minister of the British Cabinet, has the melancholy distinction of being the first man killed by a locomotive. He was killed by Stevenson's "Rocket" at the opening of the Liverpool & Manchester Railroad shortly after the Rainhill trials, which took place in 1829.

A correspondent of the *Valve World* describes a simple method for testing the flow of an artesian well under conditions where a weir could not be built. About forty feet of ten-inch pipe was screwed into a 90-degree elbow, connected to the top of the pipe where it came out of the ground, and near this connection was tapped a small hole for a pipe to which was attached a hand force-pump. The force-pump was used to draw red aniline liquid from a pail and force it into the pipe. At a given signal a quantity of the aniline fluid was forced into the pipe and of course, it was carried along with the flow of water, and at the same rate. The interval of time for the colored water to appear at the far end of the pipe was measured by a stop watch. Then, knowing the capacity of the pipe and time required for the flow to travel 40 feet, it was an easy matter to figure the amount of water passing per minute.

Coal stored in great heaps deteriorates in quality as time goes on; this deterioration is slow oxidation, and oxidation, slow or fast, is always accompanied by the generation of heat. There is no known way of preventing this action, but there is a way of avoiding serious results, and that is to provide means for rapidly carrying off the heat, and that is best accomplished by the free circulation of air through and around the pile. There is one peculiarity about stored coal for railroad use, when it does get on fire, that is not very generally known, says *The Engineer* (Chicago). The peculiarity about the fire in the interior of a pile of coal is that it cokes a layer of coal all around the fire, and this coked layer will not readily let water through, so that drenching the pile from the outside and expecting the water to soak in and put out the fire is an expectation which is not likely to be realized. The way to put out a fire in the center of a coal pile is to push a sharp pointed piece of perforated pipe into the burning mass, couple the piece of pipe to the shop hose and turn on the water.

Consul Fleming, of Edinburgh, Scotland, calls attention to a large paper-making machine which he says an Edinburgh firm of manufacturers has just completed. It is the largest paper-making machine ever constructed in the United Kingdom. Some idea of its dimensions may be afforded by the statement that a shed 185 feet long is not sufficient to house it. The striking feature of the machine is its great width. This is called for by the fact that the paper-mill company in Sweden, to whose order it has been built, intend to use it for the making of two sheets of newspaper, each 75 inches wide—or 150 inches of finished paper. To run a sheet of this width at the high speed of 500 feet per minute requires a machine with exceptional driving gear and rolls of extraordinary diameter and weight. The paper made is to have a better finish than is customary on newspapers in Great Britain, and to that end an enormous stack of calender rolls is provided. These rolls weigh about 70 tons—the bottom one alone weighing 14½ tons. The steam engine by which the machine is driven is capable of developing 200 horse power. With all accessories the complete machine weighs 550 tons, and a special steamer has been chartered to carry it from Leith to Sweden. It is said that the price to be paid by the Swedish company is $72,997.

A weak feature of electrical apparatus, particularly dynamos and motors, is the insulation which, being usually of a vegetable nature, is easily charred by heat and requires considerable thickness in order to have the requisite dielectric strength. The *Western Electrician* refers to a new insulation which has been used with some success in Germany that promises a considerable improvement in the matter of thickness and therefore the size of coils. The new insulation when used for very fine wires is made of asetic cellulose applied by special apparatus. This covering is tough and elastic and is unaffected by humidity or a temperature of 300 degrees F. With a thickness of only slightly more than 0.001 inch it suffices for a tension of 1,500 volts. For larger wires up to 0.08 inch diameter another substance of similar qualities but resembling enamel in appearance is employed. This insulation is also very elastic and flexible and its dielectric strength permits it to withstand from 2,000 to 2,500 volts with a thickness of only 0.0006 to 0.001 inch, being thinner even than the first-named insulation. It resists temperature up to 392 degrees and is unaffected by humidity. If these insulations are as efficient as reported it would seem that they leave little to be desired. With their extreme thinness and exceptional dielectric strength it will be possible to make high tension coils very compact.

A correspondent of *Mechanical World*, Mr. R. Berry, Birmingham, Eng., gives it as *his* theory that the width and thickness of a driving belt should be decided only by the factor of safety employed, which in a measure also decides the life of the belt. In explanation he says that if we take two belts, say one is 3 inches and the other 6 inches wide, both single leather and made of the same class of material in every respect, with the working conditions, as regards velocity and total tension between the two shafts the same, then the 3-inch belt will do a given amount of work equally as well as the wider belt, so far as gripping the pulley is concerned. But owing to the tension per inch of width in the case of the narrow belt being twice as great as in the wider belt, its life will obviously be only one-half that of the 6-inch belt. The power to grip the pulley and to transmit energy will be the same in each case, which brings us to the fact that the output of any belt in foot-pounds depends solely upon the velocity measured in feet per minute times the total tension between the two shafts, measured in pounds, and also on the coefficient of friction. No other factors need be considered within ordinary working limits. He refers to the advice often given by writers that the tension of a belt should never be increased where greater power is required, but to either make the belt wider or to make it double thickness, their argument being that unless this is done the shafting and bearings suffer. The fallacy of this is pointed out inasmuch as the total tension must be the same in either case, the coefficient of friction

being the same; hence the effect on the shafting is the same whether the tension is increased on the original belt or a wider or thicker belt is employed. He advises that single belts should not be run at a tension greater than 300 pounds per square inch of cross-sectional area, but is inclined to favor high belt speeds, up to 4,500 feet which he regards as being about the maximum speed that should be employed, for beyond this speed he asserts that no real economy exists.

One of the most desired inventions in mechanics or thermodynamics is the utilization of gas or oil for the driving of a turbine. There have been many attempts to solve the problems, one of the principal of which is the compression to a sufficiently high pressure of the air required for combustion, and, although the success of the past has been largely negative, the process of trial and error makes progress. A French engineer, M. A. Barbezat, has constructed an experimental turbine which is worth notice, although it is on perhaps too small a scale to prove commercial potentialities. His machine is a continuous combustion turbine. The combustion chamber is lined with refractory material. The petrol is fed through a nozzle having an outer ring, forming a passage surrounding the petrol nozzle for the supply of high-pressure air, from a compressor on the turbine shaft. The air and petrol are ignited electrically and attain a temperature of 1,800 degrees C. (3,200 degrees F.). The gas given off by combustion passes out of the chamber through nozzles, impinging against and driving the blades of the turbine. To keep the blades cool low-pressure steam is also admitted into the turbine casing, this steam being generated in water jackets around the gas nozzle. This turbine is said to give a thermal efficiency of 18 per cent, and that improvements now being made will increase this to 26 per cent. The question seems still to be the efficiency of the compressor.—*Practical Engineer.*

The camera is a very useful instrument in the shop for the purpose of record and illustration, but it has another useful field that is used to a very limited extent, and that is microphotography. It is the impression of most people that microphotography requires the use of highly expensive apparatus and an operator skilled in this particular branch. A writer in the *Scientific American* of November 11 describes a simple apparatus for making microphotographs which requires nothing more than an ordinary camera with focusing glass and a cheap microscope costing $1 or less. The microscope is seated in a wooden block which is set on the camera bed in front of the lens so that the axis of the microscope is in line with the axis of the camera lens. The subject to be microphotographed is mounted on the microscope objective, which, of course, is faced toward the light. The distance between the lens of the camera and the microscope depends upon the circumstances and will have to be found by trial, the distance varying from, say, one inch to immediate contact between the microscope and the lens. The lens should be wide open and no stops should be used. Time exposures, of course, are necessary, from thirty to forty-five seconds being usually sufficient on a bright day, using a fast plate. The time required depends also upon the degree of magnification, the greater the magnification the longer the time. The apparatus must be rigidly supported to prevent vibration, as otherwise there will be a noticeable lack of sharpness in the negative.

GALALITH, A NEW INDUSTRIAL PRODUCT.

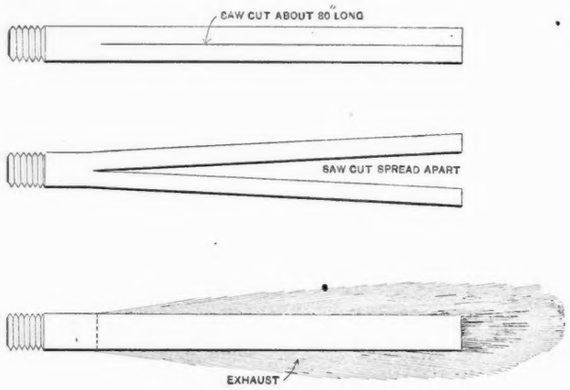
In the June, 1904, issue a short note was published on a new industrial product called "galalith," which is made from the curd of cow's milk. In a recent report Consul-General Guenther gives some additional information on this new useful substance:

"Galalith is a new horn-like product from cow's milk. From the milk of certain species of plants very valuable products have for a long time been made for the manufacture of plastic goods, as, for instance, hard rubber, known to everybody. That animal milk, especially cow's milk, also contains a similar exceedingly valuable ingredient is shown by the new horn-like substance galalith. Incredible as it may sound, galalith is in fact made entirely from cow's skimmed milk, without addition of foreign substances, only by employing a certain process of hardening. The process of manufacture is protected by patents in all civilized countries.

"Galalith is produced in all colors, various marmorean designs, and imitations; the imitations of turtle-shell, amber, corals, etc., are as similar to the natural product as one egg is to another, so that galalith turtle-shell, for instance, is hardly to be distinguished, even chemically, from genuine turtle-shell. The colors are the finest and most brilliant. Compared with celluloid, galalith possesses the essential advantage that it is absolutely odorless and not at all inflammable. In consequence of its properties, galalith is to be classed with the most precious natural products, but can be procured at much lower cost. It is already used for the manufacture of combs, clasps, hairpins, cigar and cigarette holders, handles for pocketknives and razors, handles for umbrellas and canes, backs of brushes, snuff boxes, rings, inlaid ornaments for fine furniture, balls and pearls, buttons, penholders, pencils, paperknives, seals, crochet needles, chess figures, dominoes, dice, etc."

SIMPLE GAS ENGINE EXHAUST MUFFLER.

A simple device for making exhaust of gas engines noiseless is briefly described in an English publication, but in a manner which leaves some doubt as to the exact construction. It is, however, worth noting, and we have drawn the accompanying sketch which appears to us to be the idea described. The exhaust pipe is split for about 80 inches from the top, and the split ends are opened by bending the halves of the



Gas Engine Exhaust Muffler.

pipe apart until the top of the slot has a width equal to the diameter of the pipe. The puff of the exhaust then spreads out like a fan and the discharge into the open air takes place more gradually than it would from the ordinary opening. This practice is said to be effective in reducing the sharp explosive sound of the exhaust, but the best results depend somewhat upon the flare of the tube. Of course the length also is a factor and would be necessarily greater with a large engine than a small one.

WATER POWER IN THE ALPS.

Consular Report.

In upper Italy, Switzerland, and France great progress has been made within the last few years in utilizing water power for electric currents, while in this respect Germany has somewhat lagged behind. The cause is, however, easily found. Germany is blessed less with natural water power than the countries named. It must be borne in mind that the number of waterfalls and their quantity of water is of less importance than the height of the falls. A fair illustration is found in Sweden, which, however, has also made great efforts to utilize its water power. In Germany the Danube and the Rhine, with their tributaries, are principally to be taken into account.

An exhaustive article in the *Electrotechnical Advertiser* deals with the problem regarding progress made in Germany, and especially in Bavaria, in the utilization of natural water power. Since 1899 there has been in Bavaria a State Hydrotechnical Bureau, which has made systematic and thorough measurements of all the river districts. Certain results are, however,

restricted only to about one-third of the Kingdom, but they include the rivers coming from the northern slope of the Alps. With reference to the Danube it has been determined that, as far as its course in Bavaria is concerned, its water power, inclusive of all Alpine tributaries, is about 1.9 million horse power. Of this only 37 per cent., or 700,000 horse power, could be converted into useful power. It is estimated that the water power of the entire northern slope of the Alps is about six million horse power.

Of the 700,000 horse power available in upper Bavaria, so far only 75,000 has been utilized, or a little over 10 per cent, while in Switzerland and in the Austrian Alps 350,000 horse power, or 15 per cent, has been obtained from the natural water power. Further development depends upon whether the electric power so obtained from the water forces can be employed profitably. Mountain railroads, which are especially adapted for the employment of "white coal," can only be made profitable where the scenery is very attractive. The electrochemical and the electro-metallurgical industries are most interested in such power plants. The factories on the river Lech at the Rhine falls, etc., are illustrations.

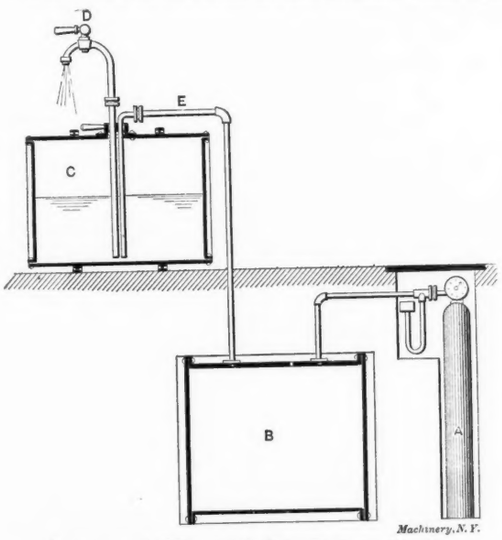
The rivers of the Bavarian Alps possess a considerable disadvantage compared with those of Switzerland and upper Austria on account of the lesser height of their falls. The turbine industry has therefore been obliged to resort to peculiar methods in order to utilize in a satisfactory manner the waters of rivers where the fall is limited.

SAFE STORAGE OF EXPLOSIVE LIQUIDS.

At a meeting of the Hanover Branch of the German Engineers' Society Prof. Schleyer described a system of fireproof storage of volatile explosive liquids, such as benzine. The dangers that exist without special precautions are (1) that high external temperature may cause bursting of the containing reservoir; (2) that the vapor of the liquid may form an explosive mixture with the air; and (3) that the liquid, in case of leakage in or damage to their containing vessels, may become ignited.

The first damage can be avoided by safety-valves.

That of the formation of explosive compounds ignitable at a low temperature is, however, always present, when ordinary



Arrangement of Storage Tank for Explosive Liquids.

air takes the place, in the reservoir, of that portion of the liquid which is drawn off. The attempts which have been made to protect the contents of the receptacle by means of fine wire gauze on the principle of the Davy safety lamp have proved futile, as the gauze is so easily injured, and if red hot affords no protection.

Absolute safety from explosion can be attained only by preventing the formation of explosible vapor mixtures. One way of accomplishing this is to replace the dangerous liquid which is drawn off, by an equal volume of a non-oxidizable liquid—as for instance water—or of an "indifferent" gas such as carbonic acid gas. Experiments have shown that the admixture of only one-fifth part of carbonic acid gas effectually prevents explosion.

The danger can be further lessened by such an arrangement as will insure that if a fire occurs near the reservoir of dangerous liquid the latter will be automatically transferred, by the resulting vapor pressure, to another reservoir, which shall be in a fire-proof situation.

One such arrangement is shown in the illustration. *A* is a cylinder of compressed carbonic acid gas; *B* a fire-proof subterranean reservoir; *C* the ordinary reservoir which may become exposed to fire; *D* the tap. As soon as *D* is opened, the compressed gas drives the liquid out of *C* and takes its place, thereby precluding the possibility of explosion at that place. Should by reason of a fire the gas pressure in *C* rise, the liquid will flow by the pipe *E* to *B* and there be in safety; that is, will leave the place of danger, automatically. The carbonic acid in *B* will escape through the U-tube, which is filled with mercury, and which also serves as control for the reducing-valve. If the reservoir should be injured by the fire, the carbonic acid will escape and act as an extinguisher. Water may be used instead of carbonic acid gas. R. G.

THE CHICAGO FREIGHT TUNNELS.

Times Engineering Supplement, September 20, 1905.

During the past four years Chicago has been occupied in providing itself with a system of shallow tunnels, on lines which differ broadly from underground means of transport followed in other cities. The most congested quarter of the city is being duplicated some 33 feet below the road level by the construction of underground passages following the plan of the streets, constituting what may suggest lower stories of the thoroughfares above. Their special feature is that they are only to be utilized for the conveyance of goods. Up to July 31 last, practically 33 miles of these tunnels were completed, and the work is now being pushed forward at the rate of about 500 feet a day. The mileage completed does not mark a limit to this curious network of freight tunnels, and they will probably reach more than double the length in course of time. But what already has been done has not been altogether plain sailing. Subsidences and street depressions have lately occurred, into which a committee has been inquiring, and they find them to be attributable to the neglect of employing air-pressure (which they order shall be used in all future work) in cutting the connections and by-passes branching from the main-line tunnels. For the latter the pneumatic system was used, and no subsidence is to be traced to them. The Chicago city authorities, apparently, have generally allowed the constructing company a free hand in their operations, to judge from the comments of the committee, who have availed themselves of the occasion to investigate the checkered history of the whole work. The result is a critical report in which they regret that a scheme of such magnitude was not based upon a coherent and comprehensive plan, and they point to the report of the Royal Commission on London Traffic as indicating the inquiry which should have been made before the tunnels were begun.

Chicago claims to have discovered a golden rule for modern urban transit, namely, "streets for the people, tunnels for goods." On the face of it, underground roads of this kind seem more suitable for goods than for human transport. No passengers, in fact, are to be carried in the Chicago tunnels. How far the freight tunnels of Chicago will effect a clearance of the vehicles which overload her business quarter remains to be seen; but the project at any rate appeals to common sense, and the wisdom of the experiment cannot be questioned. It may be remarked, however, that the compact area of the city's industrial center lends itself to the establishment of a network of freight tunnels beneath it. Were the business quarter spread over a wider area, somewhat segregated in parts, and generally less concentrated, as is the case with many other cities, a system of freight tunnels would not perhaps be so practicable. This "down-town" district, it may be mentoned, although only 1½ square miles in area, is regarded as the most congested in the world. Therein is stated to be centered 35 per cent of the railway mileage of the United States, 14 per cent of the entire world's mileage, the termini

of 25 trunk lines, and in and out of it are shipped 40,300,000 tons of goods in one year. These figures may slightly err on the side of exaggeration and admit of some correction; but there is no doubt that the traffic is far too great for the small area containing it.

Originally, the purpose of the promoters was the more modest one of running conduits a little below the street surface to carry telephone cables; but the idea of tunnels was eventually adopted, and the scheme finally matured in the linking of an automatic telephone system with freight transport, such as the carrying of mails, newspapers, parcels, and general goods, through the tunnels. Building operations have proceeded without even owners of property being aware of the extensive excavations going on, as the removal of soil by cars was effected at night, through shafts sunk from the street levels, and from an opening in the river bank, whence it was shot into barges. Unlike tube lines designed for passenger traffic, the tunnels do not even reveal their existence by emerging into stations at the street level. There are, in fact, no stations; as what may pass for such are merely elevators connecting with the cellars of large establishments by means of spur tracks along the line. Down these elevators the goods will be sent, for despatch through the tunnels to the railway termini, where there are also connecting elevators, as well as at the main and branch post offices and goods depots. The plans of new buildings now in course of construction even go further by fixing the foundations on the same level as the tunnels, so as to admit of the basement answering the purpose of a freight railway station under the ground. When in Chicago the writer was shown several of these "basement stations," for that is what they practically are. Every building in the business district of Chicago can be equipped with tunnel connections, which would place it in direct communication with the trunk lines, and there is apparently no limit to the extent to which "stub" tracks can be branched off at any point along the line for this purpose. The tunnels also admit of special facilities for the transit of coal, and for the quick disposal underground of ashes and débris from the streets.

The thirty-three miles of tunnels so far complete, with the necessary by-passes and intersections, 300 in number, are at present only being used for the purpose of removing soil to the lake shore. They are of horse-shoe section, the walls and floors being lined with concrete. Gridironing the "downtown" district, the roofs restricted to a distance of not less than 24 feet 6 inches from the street surface, they practically run beneath every block, with cross-over curves at each intersection. For about a mile there is a trunk tunnel, 14 feet 6 inches high, and 12 feet 9 inches wide (inside measurement), with 21-inch floors and 18-inch concrete walls; the rest are lateral tunnels 7 feet 6 inches high, by 6 feet wide, with 13-inch floors and 10-inch walls. The excavation operations for these main tunnels, which generally yielded a blue clay, were effected under pneumatic pressure, and spades and hooped-shaped drag-knives were used in cutting through. As each 20-foot section was excavated, 5-inch steel channels, in two pieces, bent to the exact shape of the tunnel curves, were set up, 3 feet apart, with lagging planks or frames placed outside of them, and the space between the lagging and the surface of the clay was filled in with concrete properly packed to bond it with the last completed section. The floor was first laid, then the walls on each side, and the key space at the top was next filled up and thoroughly rammed to prevent any movement of the body of the clay, which would disturb the stability of the important buildings above. All the 35,000 cubic yards of concrete used were manufactured in basements near the shafts, the material (cement, sand, and gravel), being passed down an inclined chute from the street on to a conveyor belt driven by electricity, which delivered it into storage bins. At the intersections, where the concrete has a less proportion of sand or gravel than at other parts, and is therefore richer, the corners are rounded off, and the roof is supported by transverse rolled steel joists or roof beams, with concrete arches between them. The view of the completed tunnels from the intersections suggests ancient catacombs.

The cables of the automatic telephone system now in operation, which are already serving between 4,000 and 5,000 stations, are strung along the roof and walls in lead sheaths, and pass up lateral drifts, 3 feet in diameter, which connect with the street level, then along manholes near the surface, and through the ordinary conduits to the various buildings.

The permanent way is of 2 feet gage, laid with 56-pounds flangerails, over which 5-ton electric automobiles are being run experimentally, taking their power from an overhead trolley wire; but some parts of the system are equipped with a third rail conductor. The tunnels have bright incandescent lights, and a slow service is contemplated in which no signals are to be used, and all the switches at the cross-over points will be worked by hand. The operation of the traffic, in short, will be more applicable to slow movement of street cars in crowded parts of a city than to steam railways. The president, Mr. Albert G. Wheeler, estimates that 30,000 tons of freight will be handled daily when the tunnels are in operation.

STEPS AND PRESS EMPLOYED IN MAKING RAPID-FIRE CARTRIDGE SHELLS.

The successive steps employed in heading cartridge cases or shells were illustrated in a recent issue of *Engineering* in connection with a description of a cartridge case heading and indenting press, built by the Vauxhall & West Hydraulic Engineering Co., London. The press was designed for performing the heading operations upon ammunition shells used in rapid-fire guns. After a shell or case has been drawn to the required internal and external diameters and the mouth trimmed, it is necessary to redistribute the metal in the solid end of the case so as to form the seat for the primer and projecting flange of the head. This requires three operations, known as "first" and "second indents" and "heading." The drawn shell is shown at *A*, Fig. 1, and at *B* it has received the first indent which raises a boss on the interior of the shell for the primer and initiates the operation which finally results in forming the flange. At *C* the primer hole is shown perforated and at *D* the surplus metal is shown headed over to form the flange.

The hydraulic press required for these operations is necessarily heavy (116,500 pounds), and capable of exerting great pressure. The top entablature of the press, Figs. 2 and 3, forms also the main cylinder *A*, in which works an inverted ram fixed to a guide cross-head, *B*, with adjustable slippers,

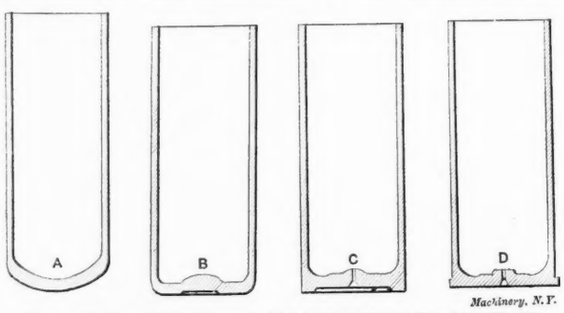


Fig. 1. Order of Operations in Making Rapid-fire Cartridge Shells.

these working on the columns of the press which connect the upper entablature to the case. To the ends of this cross-head are fixed the ends of two rams, *C*, for returning the main ram into its cylinder after each stroke. The cylinders in which these side rams work are connected direct to the hydraulic-pressure mains, so that the side rams exert a constant upward pressure below the cross-head, and thus raise the latter whenever the valve of the main cylinder is open to exhaust. The base of the press is a cored casting, from the under-side of which is suspended a powerful ejector ram, *D*, for forcing a headed cartridge-case from the die; on the upper face of the base is arranged a circular block of gun steel, which can be rotated through 180 degrees by the wire rope and two jigger cylinders, *E*, seen in the illustration. The die-block, which is fitted with two dies, is carried by a vertical shaft, and is also recessed into the top of the press base. The two dies are diametrically opposite each other, and are so arranged that when one die is exactly under the center of the main ram the other die is over the ejecting-ram.

In describing the working cycle it is assumed that the main ram is at the top of its stroke, the ejecting ram at the bottom

of its stroke, and the rotatable die-block is in one or other of its working positions. A partly finished case, of the shape shown at *A*, in Fig. 1, is placed in the die-block over a mandrel which rests over the ejecting-ram; by means of the hydraulic jigger cylinders the die-block is rotated through an angle of 180 degrees, and the cycle of operations now commences: The case being under the center of the main ram, the follower of which is fitted with a revolving die-plate holding three dies—*i. e.*, two indenting and one heading dies—the dies are turned until the first indenting die is over the cartridge-case, when pressure is admitted to the main cylinder, and the ram forces the die into the solid metal of the case, and makes a shallow depression in the center of the latter, as shown by *B*, Fig. 1. The main ram now ascends, and the second indenting-die is brought into position and the stroke repeated, which leaves the case with the central depression so enlarged that the end of the case has the appearance of a flat circular plate surrounded by a low wall, as shown by *C*. The ram is then again raised, and the die-plate swung round until the heading-die is under the ram, which then descends and flattens down the wall left by the last operation, and thus forms the rim of the cartridge-case as shown by *D*.

During these three successive working strokes of the main ram the lower die-block has remained stationary, and may be assumed to contain in the die-block over the extractor-ram a finished case. This case is next ejected, and a new case placed in the die, so that, when the three strokes of the main ram are completed, the die-block may be rotated, and the cycle of operations repeated. The method of rotating the die-block is simple, and is decidedly preferable to the more common means of a rack and pinion; as the rope is always subjected to the tension of the smaller jigger ram, which is of course constantly under pressure, so that it is impossible for there to be any play or lost motion. The exact reversal of the die-block is limited to 180 degrees by the nuts and lock-nuts on the guide-bars of the crosshead connected to the larger jigger ram; and any stretch in the rope is automatically taken up. In addition to this, the length can be adjusted by the screwed eyes at each end of the rope.

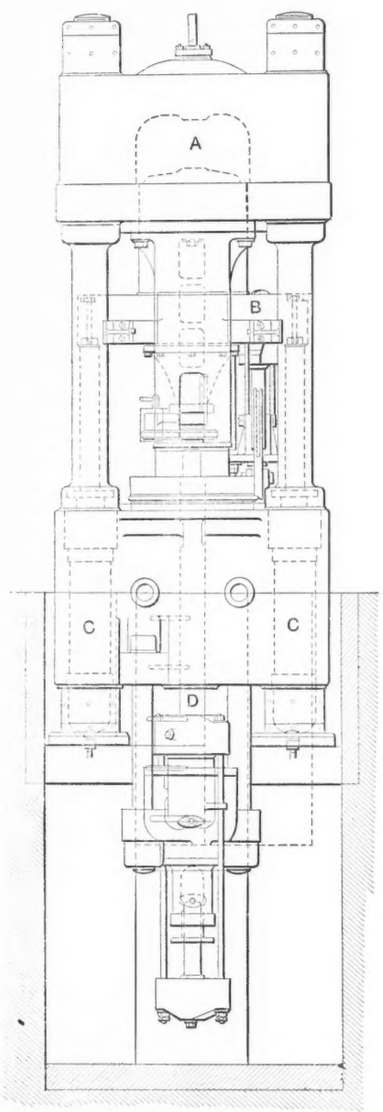
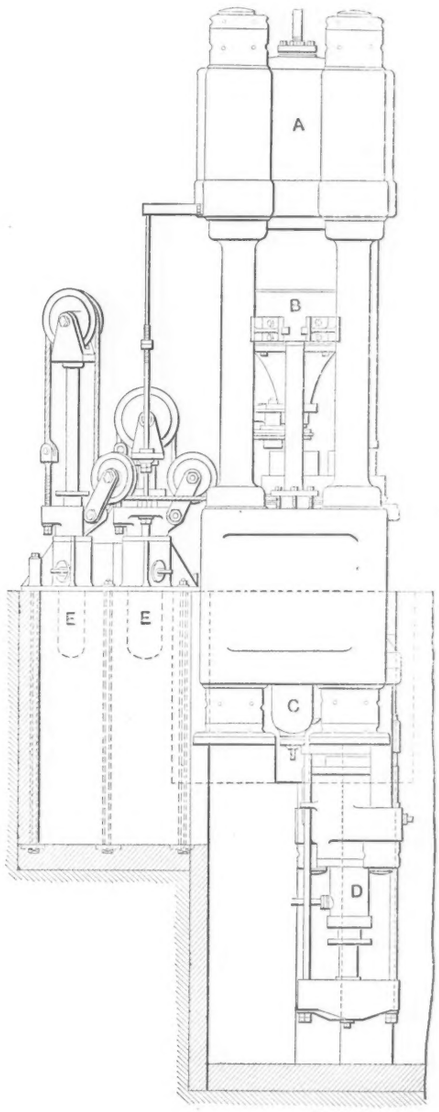


Fig. 2.



Machinery, N.Y.

Fig. 3.

Front and Side Views of Cartridge-case Heading and Indenting Press.

THE SMOKE QUESTION.

W. H. Booth, in Times Engineering Supplement. Nov. 5, 1905.

The public generally, and, it is to be feared, many engineers also, regard smoke production as inevitable. Patentees and makers of such apparatus as mechanical stokers, devices for admitting air and for increasing draft, of hollow bars, and a hundred other things, all labor under the disadvantage that they do not appreciate the scientific aspects of the combustion of fuel, and none of the many appliances sold for the prevention of smoke make any thorough attempt to combine the few essentials of perfect combustion. These few essentials are the provision of an adequate quantity of air to combine with the fuel; the sufficient mixture of such air with the gases from the fuel; the provision of a suitable space in which these gases can complete their union with the oxygen of the air; and last, but equally important, the conservation of a temperature sufficient for such union. It is this last essential that is usually—indeed almost always—absent from all devices. Thus in the internally fired boiler of the Lancashire and similar types, the furnace is bounded by water-cooled plates, while the whole of the combustion chamber is water-cooled, and is frequently also provided with still further refrigerating agencies in the shape of water pipes placed diagonally across the tube. In most water-tube boilers the gases from the furnace rise vertically from the fire and pass directly into a closely set bundle of cold-water tubes. The mixture of gas and air which is fairly accomplished by the longitudinal sweep over the fire in the Lancashire boiler is absent in the common furnace arrangement of most water-tube boilers. Thus, while the Lancashire boiler possesses a furnace correct in form, it lacks temperature. The water-tube common furnace lacks both the form to produce mixture and the temperature. The result is that while a so-called smokeless Welsh coal can be burned smokelessly in the Lancashire boiler it will produce smoke in the water-tube boiler.

These facts lead up to a consideration of coal as a smoke producer. True anthracite will produce no smoke in any furnace. In a badly designed furnace it may burn imperfectly to carbonic oxide with great loss of effect; but there will be no

colored smoke. Bituminous coal alone will produce smoke, and bituminous coal varies very greatly in quality. It ranges from the best class of smokeless Welsh, which contains little volatile hydrocarbon, up to the fully bituminous qualities which may contain 30 per cent or more of hydrocarbon.

When a bituminous coal is employed, that part which is solid carbon is burned on the grate. The volatile portion is distilled into gas, and burns beyond the grate when mixed with air and kept sufficiently hot to burn. Obviously a coal consisting mainly of carbon, which will burn on the grate, will produce a vast amount of heat at the grate surface, and the volatile portions when driven off are raised to a sufficient temperature to burn promptly before they have traveled far and become cooled by contact with the cold boiler surfaces. But with a highly bituminous coal there is very much less carbon to burn at the grate surface, and so much less heat is therefore evolved. Much of this heat is promptly absorbed in effecting the distillation of the volatile parts of the coal, which renders latent a large amount of heat in the process of vaporization. Thus with less heat generated, and more hydrocarbon to distill, there is not much energy left over to heat up the volatile matters to ignition temperature. On the contrary, their volume is great, and the surrounding boiler plates so greedily absorb heat from them, that at the time of firing there is too low a temperature to permit of perfect combustion. The half-consumed gases, when thrown against cool boiler surfaces, split up, therefore, in a curious manner and throw out carbon as soot. They do this even when fully mixed with air if the temperature is too low for complete combustion.

According to the percentage of hydrocarbon, therefore, will be the intensity of the smoke. Mechanical stokers, by continuously supplying fuel to the furnace, reduce the volume of the smoke, but they are by no means able to cure the evil. Often they are merely equalizers of the rates of smoke production. Given, therefore, proper air admixture with the gases, and space in which combustion can be completed, there remains only the conservation of temperature as the final essential to smokelessness. This can only be secured by surrounding the path of the burning gases with a non-absorbent substance such as firebrick. Now there is nothing to prevent the employment of firebrick for the lining of a circular flue tube of a Lancashire boiler. This is done when the fuel is dust coal blown into the furnace by a blast of air, and the burning of this fuel is carried out without smoke. It is done also where liquid fuel is burned, because liquid fuel, being composed wholly of hydrocarbons, and having nothing solid, smokes so foully that proper furnaces are rendered absolutely necessary. It should, therefore, be equally possible to line any internal furnace for the purpose of maintaining the heat of the gases until they are so far burned that they may pass on to a colder unlined portion. The peculiarity of the hydrocarbon gases is that the hotter they are kept the more quickly they burn and the shorter is the flame. If in an unlined furnace the flame of a certain coal extends to a length of 30 feet, it by no means follows that the refractory lining must extend this length, for possibly the lining of about 10 feet would so quicken combustion and shorten flame that a 10-foot length would be all that was necessary. No mere lining of a faulty furnace will make up for incorrect form. Before the water-tube boiler can be made smokeless the gases must cease to rise directly from the fire to the tubes. They must be made to pass along the fire, mixing, as they flow, with the air to burn them, and they must then escape to a brick chamber in which they can burn before they come into contact with the tubes.

The recent trouble in regard to the electric railway power stations in London, which are such great smoke producers, is entirely due to the errors in furnace construction, and no cure is likely to result from any change in the stoking. The bad form of the furnaces was pointed out by the writer long before the stations were even thought of, but the old erroneous designs were persisted in, and the writer does not hesitate to state that less smoke can only be made with the present form of furnaces by a disgracefully excessive introduction of air with consequent waste of fuel. Prevention with economy can only be brought about by a complete change in the furnace design, though it is a matter for regret that where engineers put bad furnaces to their boilers they usually so arrange the boilers and their environment that a cure is difficult, if not impracticable, without costly structural alterations. But it is certain that there need be no smoke even from water-tube boilers, and where smoke is produced it is entirely the fault of the engineer responsible for the design in the laying out of the station. If magistrates who have the law to enforce would go to the trouble of finding out the truth, instead of listening to the rubbish talked about earnest efforts to subdue the smoke by trying patented nostrums and various forms of mechanical stokers, they would probably enforce the provisions of the smoke act in such a way that every electrical station in London would be compelled to do the one thing necessary by building its boiler furnaces of correct form and of proper materials. It is unreasonable to expect a cure of smoke from mechanical stoking alone, though much may be accomplished by them if combined with brick arches.

COWPER-COLES GALVANIZING PROCESS.

At a meeting of the Society of Engineers, November 6, 1905, a paper was read on "The metallic preservation and ornamentation of iron and steel surfaces," by Mr. Sherard Cowper-Coles. The author first referred to the theory of protective metallic coatings for iron and steel, and gave examples of corrosion caused by two metals being in contact, with the presence of moisture. He then described the process of hot galvanizing, or dipping in molten zinc, and some special forms of apparatus employed for the galvanizing of sheets and wire. The next process described was electro-zincing, or cold galvanizing, which consists of electro-depositing zinc from aqueous solutions. A regenerative process was then described and particulars were given of the way in which zinc dust is employed to regenerate the electrolyte and how the voltage between the electrodes is reduced by employing compound anode and cathode bars. Particulars of cost of plant and working the process were also given.

Iron Inlaid with Zinc in Decorative Design, by "Sherardizing" Process.

The greater portion of the paper was devoted to a new process of dry galvanizing or "Sherardizing," discovered by the author. A remarkable feature of this process is that iron and steel can be coated with metallic zinc, by merely bedding it in zinc dust in a drum, placing it in a furnace and raising the zinc to a temperature several hundred degrees below the melting point of that metal. Zinc dust consists of small particles of zinc coated with a film of oxide, and is produced by zinc distillation processes and must not be confused with zinc oxide. When the drum has been charged with the articles to be treated and zinc dust, it is placed in the furnace which is heated to 500 degrees or 600 degrees F., which is some 200 degrees below the melting point of zinc, the thickness of zinc coating being dependent on time and temperature. On opening the drum the articles are found to be covered with a silvery

coating of zinc which has become alloyed or amalgamated with the iron surface. The process of dry galvanizing is found to be cheaper than hot or electro-galvanizing as there is no waste of material, while the expenditure of fuel is small and the plant simple and inexpensive. Particulars were given of the plant employed and a favorable comparison was made of the zinc coating obtained by the new process as against the zinc coating obtained by the hot and cold processes.

An interesting description was given of the application of the process for inlaying and ornamenting metals. The articles to be inlaid are coated with a stopping-off composition, those portions where the metal is to be inlaid and onlaid being removed. They are then packed in an iron box containing the metal to be inlaid in a finely-divided state and heated in a stove. Very pleasing effects were shown to be obtained with steel plates by inlaying them with zinc, the steel being coated with magnetic oxide which renders it rustless. A copper plate can be inlaid with zinc, the thickness of the stopping-off composition being so adjusted that a considerable portion of the copper is converted into a golden colored glass, thus giving a very soft and pleasing effect with great subtlety of color. Zinc may also be obtained on a plain background. By altering the preliminary treatment and varying the length of stoving it is possible to act upon the metal plate so as to obtain, instead of the copper, beautiful color effects varying from silver-white to yellow brasses and bronzes of various shades, graduating to red copper. Among other applications the process has been found useful for case-hardening copper and coating aluminum previous to electro-plating and soldering.

IMPROVED SOLDERING ACID.

Brass World.

A very satisfactory soldering acid may be made by the use of the ordinary soldering acid for the base and introducing a certain proportion of chloride of tin and sal-ammoniac. This gives an acid which is superior in every way to the old form. The method of making it is as follows:

To make one gallon of this soldering fluid take three quarts of common muriatic acid and allow it to dissolve as much zinc as it will take up. This method, of course, is the usual one followed in the manufacture of ordinary soldering acid. The acid, as is well known, must be placed in an earthenware or glass vessel. The zinc may be sheet clippings or common plate spelter broken into small pieces. Place the acid in the vessel and add the zinc in small portions so as to prevent the whole from boiling over. When all the zinc has been added and the action has stopped it indicates that enough has been taken up. Care must be taken, however, to see that there is a little zinc left in the bottom, as otherwise the acid will be in excess. The idea is to have the acid take up as much zinc as it will.

After this has been done there will remain some residue in the form of a black precipitate. This is the lead which all zinc contains, and which is not dissolved by the muriatic acid. This lead may be removed by filtering through a funnel in the bottom of which there is a little absorbent cotton, or the solution may be allowed to remain over night until the lead has settled and the clear solution can then be poured off. This lead precipitate is not particularly injurious to the soldering fluid, but it is better to get rid of it so that a good, clear solution may be obtained.

Now dissolve six ounces of sal-ammoniac in a pint of warm water. In another pint dissolve four ounces of chloride of tin. The chloride of tin solution will usually be cloudy, but this will not matter. Now mix the three solutions together. The solution will be slightly cloudy when the three have been mixed, and the addition of a few drops of muriatic acid will render it perfectly clear. Do not add any more acid than is necessary to do this, as the solution would then contain too much of this ingredient and the results would be injurious.

This soldering acid is used in the same manner as any solution of this kind, but it will be found that it will not spatter when the iron is applied to it. It has also been found that a poorer grade of solder may be used with it than with the usual soldering acid. By experience it has been found that a solder composed of two parts of lead and one of tin works equally as well and produces fully as strong a joint as that obtained with the customary half and half solder.

INVISIBLE PLATINUM WIRE.

S. D. V. Burr, in Iron Age, October 19, 1905.

Some thirty-five years ago the late Henry F. Read, of Brooklyn, inventor of the Gem water meter, made several yards of platinum wire so fine that when wound around a white card it could not be seen except by those having exceptionally good eyes. It could be felt, and the shadow cast by it upon the card could be seen so that its presence was manifest.

The manner of drawing the wire was exceedingly simple. A steel die was first made, the hole being as small as it could conveniently be drilled and polished. Diamonds and rubies were then used for wire drawing, but the steel was easier to handle and answered the purpose just as well. Platinum was then drawn through the die as a first step. A length of the platinum wire was then put in a tube of silver which was passed through the die. A length of the composite wire was again incased in silver and the drawing repeated. After the wire had been passed through the die a sufficient number of times the silver was removed with acid and the invisible platinum wire resulted. At first the drawing was done by hand, but the starts, stops and jerks of this method were found to have a tendency to break the wire, especially when it had become quite fine. This trouble was overcome by providing a little draw bench having a pinion and gear for doing the pulling; the strain was now constant and steady, yet even with this only comparatively short lengths could be drawn. A wire three feet long was thought to be a very successful performance.

The wire was intended for use in making the crosswires in transits, telescopes and optical instruments of like character. The animal fibers employed for this purpose caused considerable inconvenience, principally for the reason that they were affected by slight changes in the humidity of the atmosphere. It was thought the metal would overcome these and other difficulties, but the wire itself possessed defects which were of a far more serious nature and prevented its employment for this purpose. It could be readily inserted and adjusted, and once placed in position it could be relied upon to stay there; but its disadvantages far more than counterbalanced these good points. The prohibitive defect arose from the fact that its surface was too bright. The instrument maker demanded a cross wire that was a dead black—one that was shiny would ruin the accuracy of his instrument. Fibers could be dyed; the metal could not be colored.

The wire manufacturer found he had produced an article which could not be used for the specific purpose for which it had been made, and for which there was no demand in any other direction. He also found that a comparatively few yards of wire would stock the market, as far as the instrument men were interested, and that there was no other demand for invisible wire. He had not produced a commercial article, but he had made a beautiful experiment.

* * *

THE DECEMBER DATA SHEET.

The December Data Sheet contains diagrams and tabulated dimensions of the settings for hung boilers of various sizes, ranging from 36 inches by 8 feet to 70 inches by 20 feet. These dimensions represent the practice of a firm which makes a specialty of building horizontal tubular boilers. The diagrams give a very clear idea of the construction of the supporting walls, combustion chambers, etc. The material was contributed by G. L. Preacher, Augusta, Ga.

* * *

Some years ago an accident occurred in a steel mill in England, causing the death of a laborer; he fell into a mass of molten steel and his body was almost instantly consumed. The ingot was manufactured into steel rails and one of them was buried with funeral service. A parallel accident recently occurred in the Midvale Steel Works at Nicetown, Pa., whereby two workmen were overwhelmed by the escape of 80,000 pounds of steel from a ladle. This ingot was buried November 19 in the shop yard also with funeral service.

A NEW DRAWING PRESS.

A drawing press is now built by the Toledo Machine & Tool Co., Toledo, O., in which there is a new arrangement of the levers and links which transmit the motion of the crankshaft to the toggle joints operating the blank holder. This press is known as their No. 167 and is made under patents recently granted and assigned to this company. The diagram in Fig. 2 shows the link, bell cranks and yoke located on the outside of the frame and operated directly from a crank on the end of the crankshaft. With this movement the required power is obtained with a minimum amount of friction and the result is that an unusually low belt power is required for a press of this capacity. The mechanism is operated by an arm, *A*, Fig. 2, the upper end of which is attached to the crankshaft and the lower end is attached to the yoke, *B*. The lower end of this yoke is guided by a reciprocating link, *C*, pivoted to the frame at point *D*, and the upper end is guided by a link, *E*, also pivoted to the frame. These two links compel the yoke to move in practically a vertical straight line under the action of the connecting rod or link, *A*.

Attached to the yoke are two other links connecting with the bell cranks, *F* and *G*, which in turn are pivoted to the side of the press frame. The outer arms of these bell cranks are connected by long links or rods with cranks on the ends of two rock shafts at the top of the frame, one at the front and one at the rear of the press, from which the motion of the toggle movement of the blank holder is obtained. The engraving, Fig. 2, shows the several parts of the mechanism in their extreme lower position while the dotted lines indicate the position that would be taken when the parts were in their extreme upper position. When the crank which drives the toggle mechanism is in its lower position the blank holder is at its bottom position and

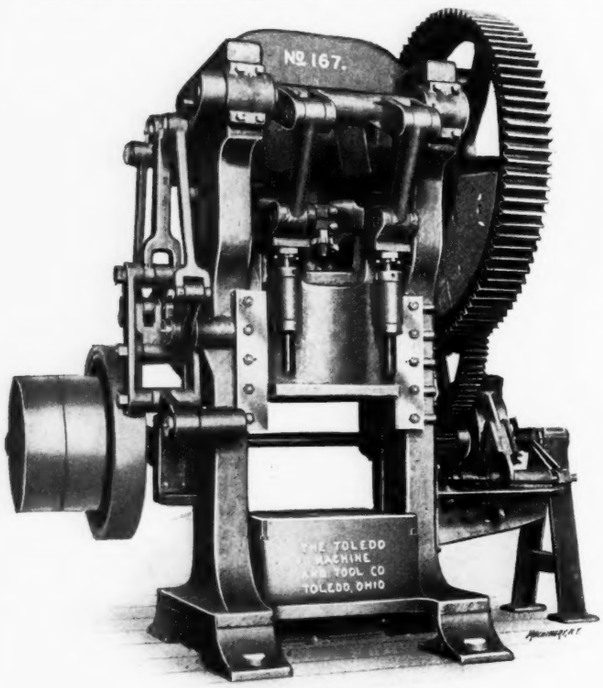


Fig 1. Drawing Press with New Mechanism for Operating Blank Holder.

maintains sufficient pressure on the blank to securely hold it in place while the drawing punch or plunger performs its work. The drawing punch receives its motion in the usual way from the main crank at the center of the crankshaft.

It will be noted that the bell crank levers, *F* and *G*, together with the links connecting them with the rock shafts, form a toggle mechanism which is passing its center at the same time that the driving crank for this mechanism and also the toggle joints connected with the blank holder, are passing their centers; and that this occurs while the blank is being held for the drawing operation. By this means an unusually long

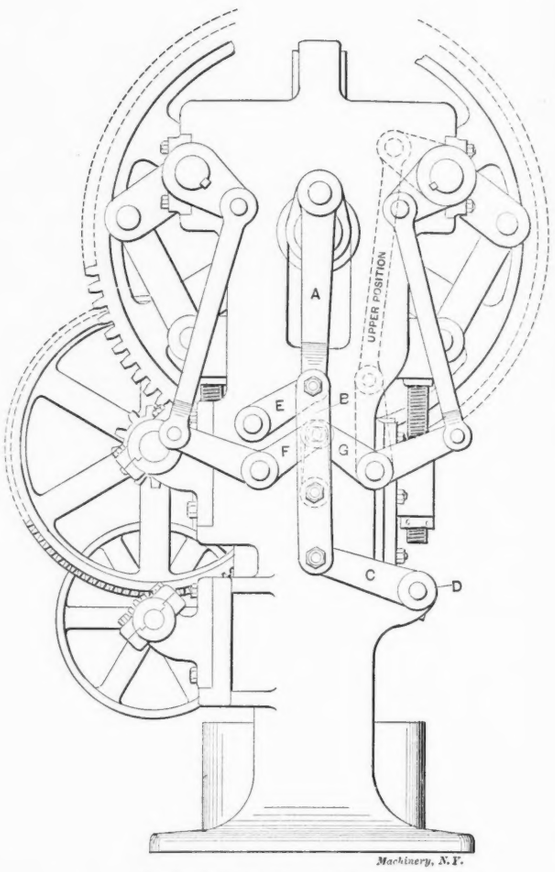


Fig. 2. Details of Toggle Mechanism.

dwell is obtained giving ample time for the blank to be completed before the holder raises sufficiently to release it.

The front and rear rocker arms at the top of press frame operating the inner toggle movement are made of steel. A heavy substantial frame connects the toggle movement and outer slide or blank holder. This blank holder is given a wide range of adjustment by means of the heavy stud or screw at each of the four corners of outer slide. The crank is connected to the inner plunger or forming punch moving inside of the outer slide or blank holder by means of a connection and screw. This connection has a cap held in position by four studs bearing perfectly on the threaded portion of screw, and in this way securely clamping the screw and positively preventing the screw from working loose. The adjustment of the screw is obtained by means of a gear and the adjusting pinion being thrown toward the operator to the front of the press, gives free access for an easy, quick adjustment.

Some of the specifications of the press are: Weight, 44,000 pounds; width between uprights, 35 inches; distance bed to blank holder, stroke down and adjustment up, 16 inches; distance bed to plunger, stroke down and adjustment up, 18 inches; stroke of blank holder, 12 inches; stroke of plunger, 17 inches.

* * *

The largest steamer afloat, in the matter of displacement, is now the *Amerika*, of the Hamburg-American line, which made her first transatlantic trip in October. This great vessel is 684 feet long, 74 feet wide and 53 feet deep. Her displacement is 42,000 tons, and gross tonnage 23,000 tons. She has accommodations for 2,300 steerage passengers and about 1,150 first, second and third-class passengers, besides which she has a crew of 520, making a possible total of nearly 4,000 souls, a population equal to that of a good-sized town. A unique feature of the boat is an *a la carte* restaurant; first-class passengers are given the privilege of buying their passage without meals, paying for their meals as they go. The *Amerika* is a comparatively slow boat, her record for the first voyage being 7 days and 17 hours. The engines are rated at about 17,000 horse power.

THE GEARED DRIVE.

J. C. STEEN.

Whether the geared drive, so called in order to distinguish it from the belt drive by means of stepped pulleys, originated with some machine tool builder who was desirous of improving a given machine, or whether it was first suggested by a machine tool user in an endeavor to secure better facilities for machine operation, it would be interesting to know, but difficult to determine.

Whatever the origin, the geared drive is a response to a demand for a better method of speed variation than could be obtained from stepped pulleys and a movable belt. The gradually growing demand for more powerful machine drives in the past has led to the widening of belts to the maximum point consistent with a desirable number of steps to the pulley and the ease of belt shifting. The limiting point for belt width may be said to be reached when a belt can no longer be shifted easily by hand. For some machines, notably lathes, the maximum diameters of the driving pulleys are generally limited by conditions inherent in the machines themselves.

Back gears were in many instances increased in ratio to make up for what could not be had by further increase of belt widths or pulley diameters, until in some cases the gap between speeds obtained directly by the belt and those obtained through the back gears became too great. When such conditions were reached, obviously, the next suggestion involved the combination of a constant speed belt of such a width and operated at such a speed as to give the requisite power, in connection with some combination of gears to be used for obtaining the desired variation in speeds. Such a combination is, in fact, a reversion of type; a going back to a system of driving formerly much used by foreign builders of machine tools. Many foreign builders objected to the use of stepped pulleys, considering their use as a deviation from, or, as being contrary to, good mechanical practice, preferring in many cases to secure speed variation by means of separate changeable gears. The objectionable feature of such a system did not suit American ideas, hence the early adoption of stepped pulleys and a movable belt as a means of quickly effecting changes even though the device was and is still considered by some designers as anomalous or paradoxical from the standpoint of pure mechanics. The substitution of the variable speed geared drive for the stepped pulley drive is therefore not due to any inherent defect in the stepped pulley so much as to its limitations as previously mentioned, and to a desire for improved facilities for quickly obtaining speed variations.

For belt-driven machines that require a variable speed, the geared drive will probably come more into use whenever its adoption will be justified from a productive or a commercial standpoint. Whatever defects may be existent in any of its varied forms will be tolerated just as long as it meets and fulfills required conditions.

As a device of utility the geared drive has passed the point where it might by some have been considered as a fad. As a matter of fact, scarcely any new device representing a radical departure from generally accepted design and practice has ever been brought out that was not considered a fad by some one. The history of machine tool progress has shown that the fad of yesterday has frequently become the custom or necessity of to-day. Extreme conservatism will see a fad where progress views an undeveloped success.

One drawback to the general adoption of any geared drive is its cost, and this will determine in most cases whether it or a belt drive shall be used; it is a matter requiring careful judgment to determine the point where the results obtained justify the added expense.

An ideal geared drive should have the following features: The minimum number of parts consistent with efficiency, to be so arranged that the least possible number of gears should be in operation at one time; any one of the entire lot of changes should be possible at one movement and without any more shock or jar than with a belt or friction drive; it should be durable, not requiring more attention than a belt drive of equal efficiency; nor should it be more expensive as to maintenance; the design should be such that it can be easily understood and operated without requiring special skill or knowledge on the part of the operator.

That these results are difficult of achievement is undoubted, and necessarily a geared drive, as they are at present designed, adds to the first cost of a machine, as well as to the cost of maintenance.

The advantage of the electric motor as a means of driving machine tools coupled with the expensive method of the earlier systems by which speed variation could be obtained electrically, gave an impetus to the development of the geared drive. To minimize expense and to improve operating conditions, results were sought for by two extreme methods; the aim on the part of the machine tool builder was to design a complete geared drive for use in connection with a constant speed motor, the result being a given variation with a limited number of speeds, while the aim of the electric motor builder was to produce the maximum speed variation in the motor alone, without the aid of gears. These extreme methods have been used in a limited number of instances, but on account of the expense of one and the limitations of the other, they are not well adapted to general requirements.

Leaving the belt drive out of consideration, the question becomes one of selecting such a combination of the electrical and mechanical methods of speed variation as will attain the desired result with the least expense and complication. This leads then to the use of a single voltage and the variable speed motor for moderate ranges of speed variation, and the combination of the same with one gear change for higher ranges of variation. Whether the variable speed motor alone, or the motor and gear combination should be used, will depend upon the requirements. In either case, the desired result can be reached with a minimum expense electrically and the least complication mechanically.

The efficiency of either a belt or geared drive depends largely upon the amount of variation and the number of speeds, together with the facility for obtaining the speed changes quickly. Neither of these methods can be compared with the electric motor with its speeds varied through the controller, particularly as to the number of speeds available, and the ease with which they can be controlled. While a larger number of speeds may not always be necessary, it is desirable that the increment of speed variation be as small as possible in order to obtain the best results as to output.

Until machine tool users realize the advantages of individual driving by electric motors, and this system comes into more general use, the geared drive will be largely used, but it will not displace the stepped pulley until its cost can be brought down somewhere near that of the belt drive of equal efficiency.

The geared drive is in a state of transition as to design and adaptability and machine tool designers are still giving it much thought, but it will probably not reach its best until there is no longer a reason for its existence, owing to the more general adoption of the electric drive.

* * *

For most industrial purposes alcohol is used in Germany, duty free, after having been "denaturized"; that is, rendered unfit for drinking purposes by the admixture of ingredients which render it impossible to be drunk, but which do not affect its efficiency for other purposes, especially in internal combustion engines. There are two methods of denaturizing, one of which is complete and the other only partial. The complete denaturization is accomplished by the addition of 2½ per cent of the so-called "standard denaturizer," which consists of 4 parts of wood alcohol and 1 part pyridin to which have been added 2⅝ ounces of oil of lavender or rosemary for each gallon of the denaturizer. Or use 1¼ per cent of the above standard denaturizer and 2 per cent of benzol. The incomplete denaturizer is sufficient to prevent alcohol from being drunk but does not disqualify it for certain other purposes for which wholly denaturized spirits would be unavailable. One method for partial denaturization is to add 5 per cent wood alcohol and ½ per cent of pyridin. Another is to add 20 per cent of shellac containing 1 part gum and 2 parts alcohol. Other methods employ 10 per cent of sulphuric ether, or 1 per cent of benzol, or ½ per cent oil of turpentine.

SOCIAL FEATURES OF THE WESTON ELECTRICAL INSTRUMENT CO.'S SHOP.

The shops of the Weston Electrical Instrument Co. of Newark, N. J., present some interesting social features. The plant is located in the outskirts of the city on the line of the Pennsylvania Railroad, and was built about five years ago. It is difficult in making a general survey of the appointments of the establishment to know just where to draw the line between the purely social and purely commercial features. Probably no such line can be drawn. Everything which contributes to the relaxation of the workman outside of working hours as well as that which enhances his comfort while he is at work has a strictly utilitarian value. The shops are well lighted, well heated, scrupulously clean, and supplied with fresh air. All these things of course work equally to the advantage of employer and employee. Besides these points, which are generally considered in the design and construction of modern shop buildings, there are a number of other features in which the direct connection between the outlay and the income is not so apparent. Most of these features are centered in a large four-story building at present unused, with the exception of one floor, for other purposes.

Fig. 1. Employee's Dining Room, Weston Electrical Instrument Co.

When the shop was erected, the second floor of the building was fitted up as a dining room with every convenience for the preparation and serving of wholesome food at reasonable prices. In the accompanying half-tone, Fig. 1, is shown a view of this room. The ceiling is lofty, the walls are painted in cheerful light colors, the chairs and tables are of polished wood, and when the tables are set for luncheon, the white napkins, with the silverware and crockery, present an inviting appearance.

Fig. 2 shows a view of the kitchen. Its equipment compares very favorably with that of a first-class club or hotel. The center table contains a row of steam kettles; on the table in the left-hand corner is a bread grinder for use in making croquettes, dressings, etc.; sinks, shelves, chopping blocks for cutting meats, and a steam kettle for washing dishes are placed at convenient points.

On this floor is also a library containing an assortment of scientific books, the gift of Dr. Weston, the president of the company, together with a large number of works of fiction, travel, poetry, essays, etc., from the Newark Public Library, of which this has been made a branch office. Adjoining the library is a small dining room where at a large table the heads of the various departments gather for the mid-day lunch, having thus an opportunity to talk over matters of interest in the management of the concern. A still smaller dining room is fitted up for the use of the directors. Both of these rooms are served from the same bill of fare as that used by the employees.

On this floor, in an ell extending in an easterly direction, is a room which has been fitted up for an assembly hall. At least once a month or thereabouts during the winter, entertainments, dances and lectures are held here. The firm employs quite a large proportion of girls and women in the shops, so these affairs can be carried out successfully without calling for outside assistance. A large number of games is provided—billiard and pool tables, chess, checkers, dominoes, etc., fencing and boxing sets, and a baby grand piano and pianola. The unique feature of the equipment is located on the ground floor of this building. A large storage tank was necessary for a supply of water for fire protection, and a virtue was made of this necessity by giving this tank the form of a natatorium. This is shown in Fig. 3. It is 150 feet long by 18 feet wide with a depth varying from 4 to 9 feet. Its sides and bottom are formed of glazed tile work, as are the sides of the whole room in which it is built. This swimming tank is larger than the largest in any private club in the country, and the shower-bath, needle-bath, toilet arrangements, etc., with which the room is provided, do

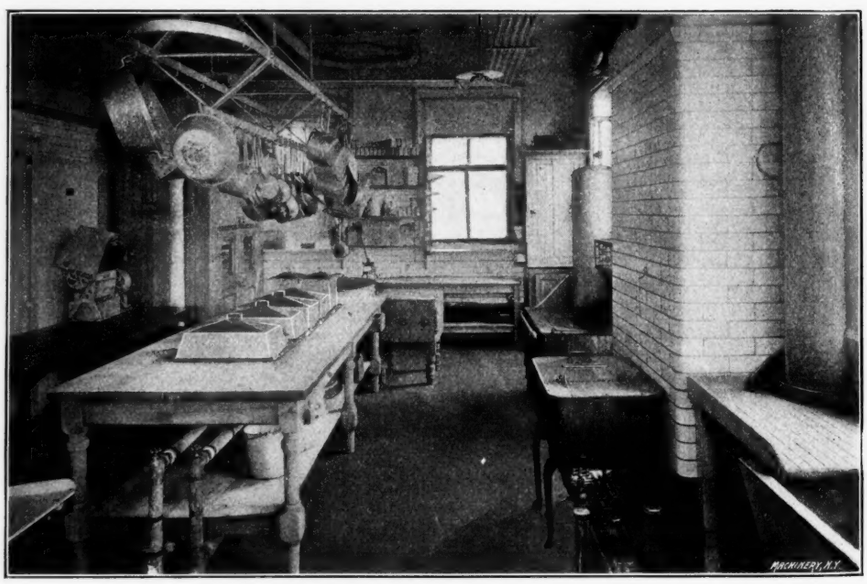


Fig. 2. Arrangement and Appointments of Kitchen.

not suffer in comparison with the best to be found elsewhere. At certain hours on specified days of the week this room is at the disposal of the female employees. During the summer when the shop base-ball team is playing and later on in the season when the foot-ball enthusiasts get busy, the bathing accommodations, dressing rooms, etc., are a great convenience.

The workmen take an active interest in the fortunes of the shop base-ball and foot-ball teams. The company owns 27 acres of land stretching in a diamond-shaped tract toward the southeast. A part of this land has been fenced off to form a ball field and the employees have built a grandstand which is being paid for by the small fees which are charged for seats therein during the games. A little further over are tennis courts that are in demand during the summer.

The vital feature of the "betterment" work of the Weston Electrical Instrument Co., lies in the way in which these various activities are carried on. After the equipment which we have described had been completed, the dining room, assembly room, etc., furnished, and everything put into running order, the whole thing was turned over to the employees as a gift, and since that time the company has taken no active part in its management. With the equipment went a working capital of $1,000. This is all under the control of the "Weston Employees' Club," in which any person employed by the company is eligible for membership. The dues are twenty-five cents per month with an initiation fee of twenty-five cents.. About eighty per cent or thereabouts of the total help employed belong to the club. The institution has been running for over three years and it is perhaps safe to judge now as to its ultimate success. At first the cuisine was turned over to a caterer with the result that after running a while, the service, cooking, and the finances all became equally unsatisfactory. The first caterer was released and another one tried in his place and the same result followed. Finally the club took the management of the kitchen into its own hands, hiring a competent chef with assistants for preparing the food and serving it. Since that time the dining room has been self-supporting.

The company pays the club for the meals served to the directors and the heads of departments, twenty-five cents per plate being the amount turned into the treasury each day. The members of the club get their luncheons for ten to twenty cents, depending on whether or not they take the full bill of fare. If desired, the meal may be ordered a la carte.

This luncheon is served by volunteers from the shop who are paid therefor by being allowed their meals free, the company granting them extra time for this purpose to insure their having a full forty minutes noon recess.

The establishment labors under great disadvantages so far as the social side of the club is concerned. Few, if any of the workmen, living as they do in Newark and Elizabeth, have homes within two miles of the plant. This means that for evening socials and dances the members must take a night trolley ride to the outskirts of the town. There is thus a tendency to center the activities of the club in the dining room feature, but in spite of this great handicap a number of social events occur each year, averaging probably about one a month, and these events are thoroughly enjoyed.

As before stated, the company has entirely resigned the management of the club into the hands of the workmen. The $1,000 which was the original capital was given with the understanding that when that was used up there would be no more forthcoming. On two or three occasions since the institution was established, the treasury balance has reached a pretty low point, in one case at least becoming a minus quantity. A little friendly encouragement on the part of the proprietors in times like these has been sufficient to renew the interest, bringing up the treasury balance to a sufficient working point. One feature of the management is especially noticeable. Beer is served at luncheon and at all the entertainments and social functions, but there has been no evidence of a tendency to abuse this privilege. At luncheon where no restrictions are imposed on its sale, scarcely more than a dozen or fifteen bottles a day are consumed. At dances and entertainments the beverage is served from an improvised bar in a curtained corner of the room, but it is invariably indulged in with moderation and there has never been any reason for limiting the sale. Again, it is interesting to note that the costly toilet equipment, an example of which may be seen in Fig. 3, with which the plant is supplied has not been defaced or mis-used in the slightest degree. In planning the details of the equipment Dr. Weston gave this matter considerable thought, and determined on the course he ultimately followed against the advice of nearly everyone with whom he talked the matter over. After making a tour of the hotels, clubs and public institutions in New York city, however, he became convinced that where the best facilities were provided, those who made use of them were careful not to injure them, but that cheapness and slovenliness in the original design and construction was invariably an invitation to vandalism. The attitude of the firm in this and other respects, for instance, the equipping of the entire plant with the most modern sanitary plumbing at a cost exceeding by two or three times that required to place it on a par with average establishments, is distinctly different from that assumed by concerns which have adopted the paternal attitude toward their employees, and on the whole this display of confidence seems to have met with the expected degree of appreciation.

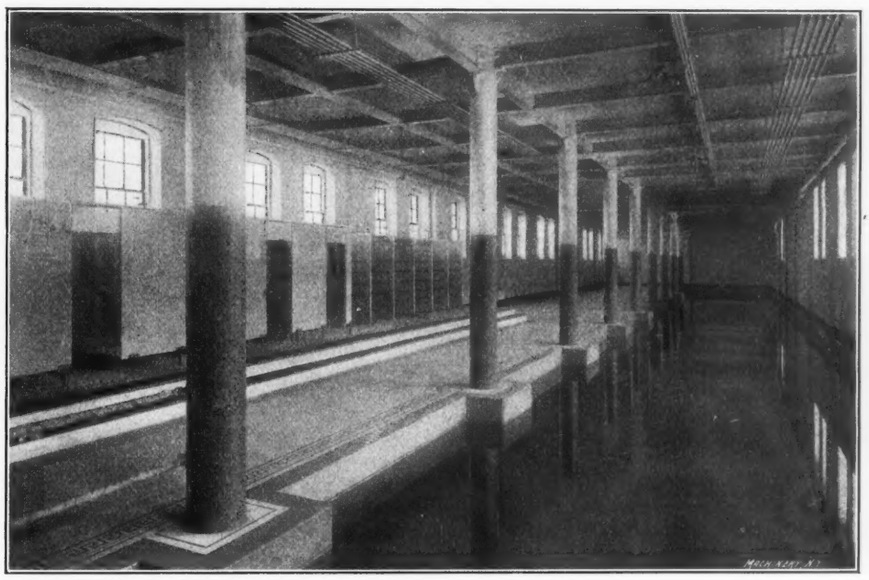


Fig. 3. Swimming Tank.

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In many manufacturing establishments it is now the common practice to prepare lists in the drafting room of the parts comprising a machine, giving at the same time the name, drawing number, pattern number, material, etc., for each piece and the number of pieces. The B. F. Sturtevant Co., of Boston, Mass., was one of the first to introduce this system by the use of so-called "production-lists" printed on thin paper with the different items lettered in black ink so that blue prints in any quantity can be taken for distribution. These form the basis for production, casting, purchase and other orders. The original is retained as a permanent record of the details of each machine, simplifying reproduction and the filling of repair orders upon obsolete designs.

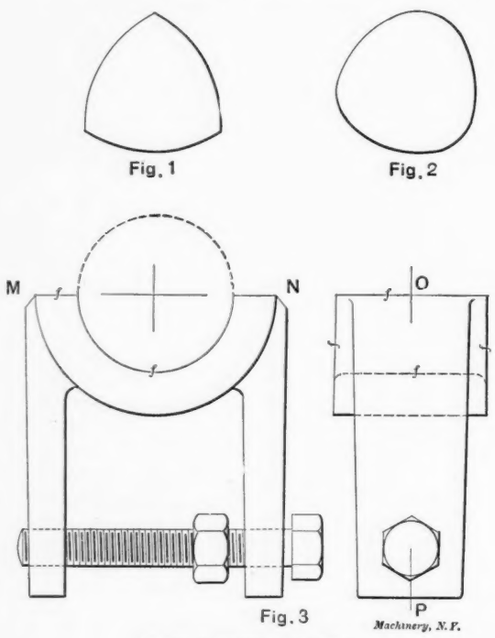
LETTERS UPON PRACTICAL SUBJECTS.

FILING UP ENGINE CRANKS.

Editor MACHINERY:

In "doctoring up" a number of old engines a surface block for use similar to using a flat surface-plate has suggested itself to me which may be interesting or useful to others when truing up cranks. The first case where the crank required attention was that of a cross-compound engine with center cranks forged solid with the shaft and on opposite sides, or 180 degrees apart, so as to make one set of reciprocating parts counterbalance the other, and permit of running at high speed. Although this engine had only run some two years it was "pounding" and was said to have run badly from the start. It seemed that the shaft was stiffer in one direction than in the other and sprung away from the lathe tool more when turning one quarter of the crank than when turning the next quarter, and thus produced an oval crank which grew worse in service.

Securing an old crank "brass," I pinched it together a little and rebored it to a diameter about half way between the old diameter and that which was to be the new one. With this rebored brass, a pair of calipers, straightedge, etc., I expected to file up those cranks truly round and straight in a manner similar to that of scraping a flat surface to a flat surface-plate. But my half-round "surface-plate" was not entirely successful in that it was adapted to only one size, while the two cranks were not exactly the same diameter to start with and these diameters gradually grew less as the high spots were worked down. Nor were the calipers an infallible guide, for when a high spot on one side came opposite a low one on the other the calipers might not indicate anything wrong. However, by exercising some patience and spending considerable time, the job was gotten into fairly good shape.



Filing up Worn Crank Pins.

The next case where the crank required attending to was that of an ordinary Corliss engine with a crank-pin inserted in a cast disk on the end of the shaft. In this instance, there was, of course, no doubt but that the crank had been all right when the engine was new some eleven years before. Profiting by my former experience with the old "brass" for a test plate the new one was made of cast iron in the form shown in Fig. 3. By means of the tap-bolt through the two lugs on the back, the working diameter of this could be adjusted to suit the crank-pin. In making the pattern, provision should be made to part the mold on either the line *M N* or *O P* so that the ends are equally flexible.

This flexible curved test plate was carefully bored to about the diameter that the crank would finish to and then pulled out by the bolt to just the diameter wanted for trying the crank. And then, as the crank worked smaller, the bolt was slackened to suit, or, if the size went slightly below normal, the nut shown was brought into use. This adjustable test plate proved much more satisfactory than any rigid one could have been, and enabled a better job to be done in about half the time required when using the rigid test piece.

Although there are portable machines in use and on the market for re-turning cranks in place, I am of the opinion that for many cases of stationary engines, at least, filing them true is the better and cheaper way. Filing should, however, be done by one who is accustomed to filing and scraping and not by the one who spends the other 364 days of the year at shoveling coal.

If there are some few readers of this paper who have implicit confidence in their new calipers to show them whether a piece is round or not let them try those calipers (yes, micrometers or any kind of calipers,) on Figs. 1 and 2, and also try those same figures with a pair of compasses.

Milwaukee, Wis. JOHN D. RIGGS.

SETTING UP AN ENGINE LATHE.

Editor MACHINERY:

For the past three years I have been operating a 20-inch swing 10-foot bed Reed engine lathe, and have had more or less trouble with it when doing fine work on account of its not boring or facing true.

When I first began running it, it was new and just set up. It bored 0.007 or 0.008 inch per foot large at the chuck end of a cut, and faced about the same amount concave. This decreased in a short time to about half the amount and did not bother me seriously on ordinary work. After about a year, I began to get work that called for a plug gage fit at both ends of a six-inch bore. At first I reset the tool two or three times during the cut and then scraped the bore to fit. This operation being tedious, and thinking that the cause lay in the alignment of the arbor, I filed about 0.01 inch off the box at the small end of the arbor and shimmed it over. For a time the lathe bored true and faced nearly true, but after this I found that sometimes it would bore small at the chuck end and sometimes large.

The lathe was set up on a 1½-inch maple floor crossing 3-inch hemlock planking laid on tamped cinders. At times there would be piled on the floor at one end or the other, either in front or back, a ton or more of castings. About six months ago the lathe was moved to another shop and set up. The first cut that I took in the new shop was on some work that required a true face. The cut was convex and I removed the shim that I had placed in front of the small box and placed it on the other side, thus bringing the box back to its original position, when the lathe faced practically true. It then occurred to me that the variation was due to the leveling up of the lathe on the floor, and the changes had been due to the pressure of the castings piled around it.

Some time later the lathe next mine was removed for the purpose of fitting it with a motor drive, and on its return I noted the manner in which the millwrights set it up. The floor was uneven and required wedges under three legs of the lathe. The millwrights did not bring shingles with them, but obtained pieces of ¼-inch and ⅜-inch boards. They found that the ¼-inch piece was not quite thick enough under the third leg so took it out and replaced it by a ⅜-inch piece. When they had finished I placed a level on a piece of key steel on the carriage and found that the bed was warped about 0.025 inch—the travel of the carriage. A few days later I had an opportunity to use the lathe and found that it did not bore or face true within 0.003 or 0.004 inch to the foot.

My lathe had been removed for motor drive and when the millwrights were setting it up again I asked them to be careful not to warp the bed. After they were gone I found that it was warped considerably over 1-32 inch and promptly removed the leg screws and shimmed up one of the legs until a

level would not vary in the travel of the carriage. I then faced a piece of work and found that it was as nearly perfect as one could wish.

I am in one of the largest machine shops in the country and all through it there is complaint about the lathes not being true. Probably 90 per cent of the lathes in the works have more or less warp in their beds from imperfect leveling in setting up, and in being screwed down to the heavy flooring. I find that my lathe will take a much heavier cut without chatter since the bed was made level. Without doubt a great deal of this trouble, in every machine shop, is due to the uneven pressure of the head and tail stock and carriage on the ways, caused by the warping of the beds.

Schenectady, N. Y. ROBERT MAYHEW.

A THREADING ATTACHMENT FOR THE SPEED LATHE.

Editor MACHINERY:

Enclosed you will find a sketch and description of an attachment for rapid and accurate thread cutting on small brass pieces. It is especially adapted to the use of those engaged in the manufacture of small threaded parts required on scientific instruments, especially on small photographic and microscopic work.

Fig. 1 shows a rear view of the lathe with the mechanism of the thread-cutting device. Mounted on the spindle as shown at *A* is a worm. For the general run of instrument work covering a range of from 20 to 100 threads per inch, I have found that a pitch of 10 threads per inch is about right for this worm. *B*, a worm wheel meshing with it and keyed to the vertical shaft *C*, should then have 40 teeth. This vertical shaft, *C*, is mounted in a bracket, *D*, fastened to the rear side of the head stock, and carries at its lower end a cam, *E*, held firmly in place by a knurled nut, *F*. Through brackets, *G*, on the rear of the bed slides a bar, *H*, with a contact plug at the end adapted to be controlled by cam *E*. Slide *J*, which

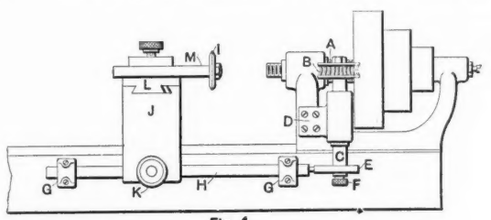


Fig. 1

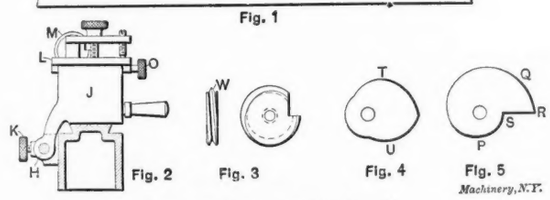


Fig. 2 Fig. 3 Fig. 4 Fig. 5

Machinery, N.Y.

Details of Threading Attachment.

rests on top of the bed of the lathe, may be fastened to this bar at any point by a knurled set-screw, *K*. Fig. 2 shows a side view of this carriage. At the front side of it a handle projects which allows it to be raised when necessary, swinging about rod *H*. The upper part of the carriage is adapted to receive the tool slide, *L*, to which is clamped the threading tool *I* and holder *M*. A knurled screw, *O*, provides for the adjustment of the tool for depth of cut.

In operating this device, a cam of suitable contour for the pitch desired is mounted at *E*. The work is held in a spring-collet, three-jawed chuck, or any of the usual devices, which may be screwed to the end of the spindle. The circular thread tool *I* is, contrary to the usual practice, mounted at the back side of the work and threading is commenced at the end of the thread nearest the head stock, the cut running out at the front of the piece, which is also contrary to the usual practice. As the lathe spindle revolves, cam *E* will revolve at a slower rate, pushing out rod *H* and carrying the slide with it in such a fashion as to cut a thread of the predetermined pitch. If the thread is long enough to require the whole throw of the cam, the lathe spindle is not reversed at all. Using the cam, for instance, shown in Fig. 5, the tool would commence to cut at *P*, and continue cutting perhaps around to *Q*, when the carriage would be lifted by means of the handle and brought back by hand again to *S* as soon as the contact plug had cleared the high point at R. For this second cut the workman brings the slide out slightly by means of thumb-screw *O* to take a little deeper chip. It will be seen that the tool will thus cut up very close to the shoulder, since its motion toward the head stock is absolutely arrested by the "dwell" on the cam from *S* to *P*. While the contact point is resting on this part of the cam, the threading tool will be cutting a recess. For the coarser pitches it is entirely practicable to have two pitches on one cam, as shown in Fig. 4. If it is desired to cut a right-hand thread of a pitch made by side *T* of the cam, it is placed in the machine, the side up shown in the sketch. If it is desired to use the other side, *U*, of the cam, the cam is reversed and a different pitch thread will be cut. For short-length threads, it will save time if a treadle attachment for reversing the spindle motion is provided. This will allow the contact point to run up on the cam the required distance, and then upon the reversal of the movement, controlled by the foot of the operator, the cam will turn backward bringing the tool back to the starting point again. This allows the hands of the operator to be free to raise and lower the carriage and adjust the tool for each cut.

The circular formed thread tool *I* may be made as shown in Fig. 1, in which case one tool will do for almost any pitch, or it may be given the form shown in Fig. 3. Here the cutter is threaded to correspond with the pitch of the thread it is desired to cut, and when the sides are trimmed off the tool is left wide enough, as shown at *W*, to trim the tops of the threads. This is especially valuable if the stock is a little over-sized. For cutting right-hand threads, the tool should be threaded left hand; for cutting left hand, the tool should be threaded right hand.

This attachment has several advantages over cutting with a leadscrew or tap and die. It saves time on making single pieces on account of the ease with which the cams at *E* may be changed to suit the pitch desired, especially since two pitches may be made on the same cam. Again, it is not always necessary, especially on comparatively long threads, to reverse the spindle. A suitable recess is always cut for the thread to run out into. The lifting of the carriage avoids the necessity of screwing the tool out at each cut, and lastly the arrangement is such that back lash is entirely avoided, the thrust of the cam *E*, controlling the carriage by a direct thrust through rod *H*. R. H. FUERLE.

Philadelphia, Pa.

"HEROIC METHODS OF DOING WORK."

Editor MACHINERY:

The point of view which Mr. Griggs takes in discussing the above topic in the November issue is a very natural one if, as I infer, he is an engine man, or if he is a toolmaker. Also the saying that "What is worth doing at all is worth doing well" is very true. But where people differ is as to what doing a job well means.

I remember that in the old shop we used to fit up a good many derrick gears. These consisted of a wooden drum on a square shaft with a cast gear and another shaft with a pinion and squared ends for the cranks. These shafts ran in split cast iron boxes which in turn were bolted to a frame made of more or less seasoned hard wood. We had a new man come in to fit up some tools, reamers among them, for we had never had anything of the kind before. About the time he had the job done an order came along for four sets of derrick gears. This new man had seen some of these gears fitted up and had shown quite plainly that he considered them a bum job. The Old Man set him to fitting them up. He reamed out the boxes with his new reamers and he water-polished the journals to the nicest possible fit. Well by-and-by they got bolted to the wooden frames and then the fun began. The Old Man had something that kept him busy off at the other end of the shop all the morning, but we could see him glancing over toward the job out of one corner of his eye, but he let Mr. Man fool over it till after dinner. Then

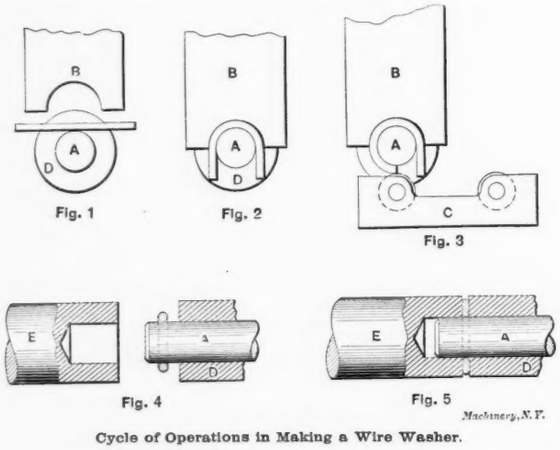
he had him turn a thirty-second off the journals so they would run. And by that time Mr. Man was glad to do it and get the job off his hands. A shaft a thirty-second inch loose in its box looks about an eighth to a toolmaker, but it was just about enough so that the gears could be turned over in the spring after they had been out in the quarry all winter.

Now this job was worth doing and it was well done, but it would be hard to convince lots of people that it was fit to go out of the shop. There is a tremendous lot of work done which must be done in ways which a tool man would consider "heroic" in order that it may work at all, and you people who publish mechanical papers are responsible for some of the lack of understanding on that score, and the technical schools are responsible for more. What you publish, naturally following the line of least resistance, relates mostly to "nice" work well done from the tool builder's point of view, so that to your readers a job done by the "heroic" method is apt to cause comment out of proportion to its importance. Almost every shop, even those doing fine work, has at least one man on whom they rely to get them out of tight holes in a hurry, and while they may look down on him between whiles they know his value well enough when there is an accident. "ENTROPY."

A NOVEL METHOD OF MAKING WASHERS.

Editor MACHINERY:

I recently saw in the shop of the American Wire Washer Co. of Unionville, Conn., a washer and process of making same which seemed to be novel and interesting. The material used by this process is wire, as is indicated by the corporate name. For the regular washers, round wire is used, for lock washers, square wire, and special washers may be made from any shape that would best suit the purpose, though a round section meets the requirements in most cases. By this process the waste of material is very small, from 6 to 10 inches only



Cycle of Operations in Making a Wire Washer.

of wire being lost at the end of each coil. This saving of material is quite an item, for by the old method about one-half of the stock goes to scrap.

The machines for making these wire washers are automatic, and from six to ten may be run by one operator. I was unable to obtain photographs to show the working of the machine clearly, but the following sketches will explain the operation of the dies. In its general appearance the machine resembles the ordinary automatic wire forming machine.

The stock is unwound from a reel, and passed first through a rotary straightener to take out the kinks. It is next cut in the proper length and deposited in position over a protruding circular plug, *A*, as may be seen in the face view, Fig. 1. A bending die, *B*, next comes down over it, giving it an inverted U outline. A slide, *C*, underneath the plug now comes up, moving first to the left and then to the right, in such a manner that the lower ends of the wire are bent around the plug by the rollers to form a complete circle. This operation is shown partially completed in Fig. 3. Figs. 4 and 5 are sectional views, plug *A* being the same here as in Fig. 1. Slide *B*, now withdraws and, as shown in Fig. 4 a female die, *E*, advances and mashes the wire into the shape of a flat washer, making it without any waste of stock. Die *E* then recedes, plug *A* is withdrawn within sleeve *D*, and the completed washer being thus stripped, falls into a box below the machine. The whole process is carried on with great rapidity.

These washers, the process, and the machinery, are patented by the inventor, Mr. H. Chauncey Hart, who conceived the idea when working at a factory where washers were being made from sheet stock. His attention was drawn to the amount of waste entailed by this process. When he went home at night he bent up a ring from round wire, flattened it with an improvised die, and had a good washer with inner and outer edges rounded and free from burrs.

Chicopee Falls, Mass. J. R. RAND.

CROSS-PLANING GAP LATHE BEDS.

Editor MACHINERY:

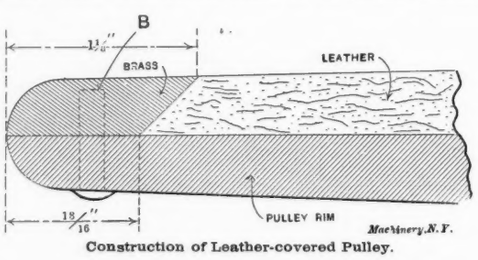
Mr. Fay's description of how he planed out a gap bed was very interesting to me as it is a job that I have had a chance to experiment with. The first time, we did it the way he shows except that we had relays of laborers to furnish motive power. We planned then to rig up a counter shaft and do it by power, but the next one came along before we got rigged up so we took the crossrail off a 38-inch planer and bolted it on across the end of the table, laid the bed on blocks on the floor and went ahead as if we had a shaper. To get the quick return right we had to reverse the planer, and since the planer was rather low we had to set it up on skids. The next bed we put around back of the planer so as to save reversing it, but we had no crane there and it was a great bother to jack up a ten-ton planer and set it down again, so a little later we tried another way. We put the beds on crosswise of the big planer but instead of a greased way such as Mr. Fay speaks of we made up a good solid iron wheel truck and a short track for it to run on. The track was framed up so as to be solid and substantial. We set the track and truck so that the part of the bed which overhung the planer table was balanced over them, and wedged up the bed on top of the truck so that the truck carried the weight. Then we went ahead just as with any planer job. No more strain was brought on the planer than with the same bed put on lengthwise. There was a slight trembling of the far end of very long beds at the instant of reverse due to the momentum of the bed and its lateral springiness, but it was never enough to bother. E. H. FISH.

Worcester, Mass.

LEATHER-COVERED PULLEYS.

Editor MACHINERY:

When in the design of machinery it is desirable that the pulleys shall be covered with leather in order to obtain the maximum adhesion of the belts, I would recommend that the following directions be followed; a pulley leather covered in this way is neat in appearance and a first-class job. This construction protects the edges of the leather covering from injury by accidentally coming in contact with tools, scaffold boards, ladders or any other obstruction likely to be placed against them



Construction of Leather-covered Pulley.

by careless workmen. Like all other good things in mechanics, the first cost will be against it, but the adhesiveness of the leather covering, and its durability, when applied in this manner, make it very economical in the long run.

For a pulley of large dimensions having to be covered with rather thick leather, I would make the pulley 2¼ inches wider than the width of the covering, measured from the edge of the pulley to the bevel edge of the leather covering, as shown in the cut. After the covering is secured to the face

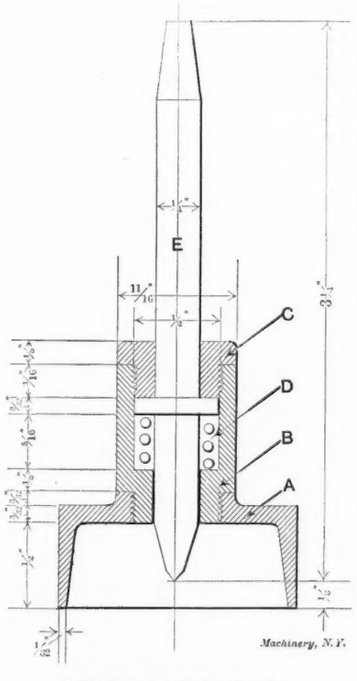
of the pulley by glue and rivets in the manner described by me in the July, 1905, issue of MACHINERY, the pulley should be put on the lathe and the edge of the leather beveled true with the edge, making the angle next to the pulley 13-16 inch from the edge and the top surface about 1⅛ inch from the edge. A strip of rolled brass ¼ inch thick and 1⅛ inch wide is beveled at the same angle as the edge of the leather and rounded on the outer edge on the upper side. This is drilled and counterbored for 3-16-inch rivets, copper rivets being preferable. The holes should be about 2 inches apart and should be countersunk on the face side. The rivets are headed over on the inside of the pulley rim. The beveled edges of the brass bands bind the edges of the leather and hold them tightly to the face of the pulley. Thus the metal guard not only protects the edge of the leather, but it adds to its adhesiveness to the pulley and gives a neat and mechanical appearance which is unsurpassed. For smaller pulleys proportionately smaller bands and rivets can be used. A leather cover put on in this manner should last for years, and should it ever need renewal the brass bands can be taken off and a new covering put on and bands replaced readily enough where ordinary repair tools are at hand. C. E. MINK.

Syracuse, N. Y.

A SELF-CENTERING CENTER PUNCH.

Editor MACHINERY:

As the name indicates, this is a punch for finding the center of a circle, given its periphery. Such an instrument would mean the saving of time in laying out work of such a character. Especially is this true in connection with flanged work of any description, where one flange, having been drilled, is laid upon its companion for marking off the corresponding holes. Now, in order to accurately find the center of these marked holes, without waste of time in "quartering" each one, requires an exceptionally keen eye, especially with holes 1¼ inch diameter and above. But with the "self-centering" punch illustrated herewith any one can readily mark the centers in at least one-quarter of the time which is required by the old method. Of course this instrument would be most useful in cases where there are no jigs used, as on special work, etc.



Self-centering Center Punch.

The construction is as follows: A set of cups, *A*, should be made for, say, 1¼, 1⅜, 1½, 1¾ and 2-inch holes, the diameter (outside) of said cups being approximately ⅛ inch less than the holes in the templets used for marking. These cups, as well as all of the material used in construction, except the spring, should be of good machinery steel, case-hardened. Into cup *A* is screwed the sleeve *B*, containing the spring *D*, and threaded at the top to receive the cap, *C*; *B* and *C* act as guides for punch *E*. The collar on punch *E* may be made adjustable, in order to allow punch to be lowered as point is ground off; this, however, is hardly necessary, as this tool should not receive rough usage, being used simply as a marker.

This makes a very handy and time-saving tool, it being necessary simply to unscrew *A* from *B* in order to change for different sized holes. CALVIN B. ROSS.

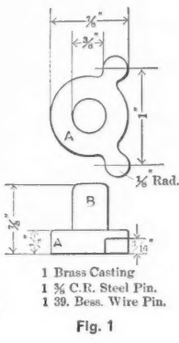
Springfield, Ohio

DRILLING AND ASSEMBLING JIG—MILLING CUTTER FOR CLOCK GEARS, ETC.

Editor MACHINERY:

The accompanying cut, Fig. 2, shows a view of a combined drilling and assembling jig which was designed and made for the purpose of facilitating the manufacture of the part shown in detail in Fig. 1. It consists of a brass casting *A* having a small machine-steel stud *B* driven into its center and securely held against turning by a small bessemer wire pin through both casting and stud.

During the ordinary course of manufacturing with a plain drilling jig some difficulty was experienced in driving the studs squarely into the casting, thereby making it impossible to replace the pieces in their proper position in the jig in



1 Brass Casting
1 ⅜ C.R. Steel Pin.
1 39. Bess. Wire Pin.

Fig. 1

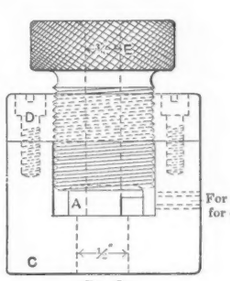


Fig. 2

Punch for Driving Studs

Fig. 3

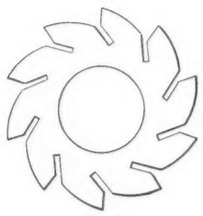


Fig. 4

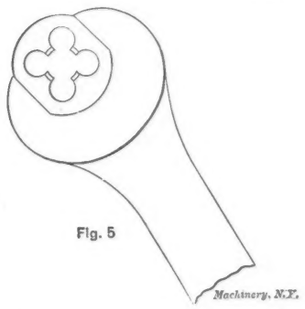


Fig. 5

An Assembling Jig, a Milling Cutter, and an Old-fashioned Die Holder.

order to drill the small pin holes. To overcome this difficulty and insure the production of interchangeable work the above jig was designed to drill the necessary two holes before removing the part from the jig. It is very simple in construction, consisting of cast-iron body *C* and a soft steel cover *D* fitted with a tool steel screw bushing *E* for locating and fastening the casting in its proper position for drilling.

To relieve the shearing strain on the small cross pin it is necessary that the ⅜-inch hole shall be drilled a trifle small in order to make a good fit on the stud. This is accomplished by using a ⅜-inch drill that has been almost entirely used up and is therefore about 0.373 inch in diameter, thus avoiding the use of letter size or other drills that are not standard. After drilling, the jig is turned bottom side up and the stud inserted through the ½-inch hole in the bottom and driven home with the aid of the punch shown in Fig. 3. This is simply a piece of ½-inch drill rod having a groove turned at one end to clear the burr made by the drill. It is evident that when driven in this manner the stud must go in square and when the punch strikes the brass casting in the jig the stud has been driven to its proper depth, that is, flush with the bottom of the brass casting. The small pin hole is then drilled and the finished part removed by unscrewing the bushing. The simplicity and ease of operation of this jig make it a good producer and its application to other jobs of similar nature has been decided upon

The small gear cutter shown with slots cut ahead of the teeth has recently been successfully used by firms having large quantities of brass or bronze gears to cut. The purpose of the slot is to provide clearance for the point of the bevel edge emery wheel used in sharpening the cutters. It reduces

the amount of hard steel which must be ground away and helps to keep the faces of the teeth radial.

The socket die holder described by Mr. Casey in the September issue is a worthy tool, its only weakness being the small headless setscrews. Having had trouble with these we made a socket on the same principle as the socket tap wrench and this has so far been good to us. But sometimes where space is extremely limited we are driven back on the good old-fashioned way of grinding two flats on the side of a round die and using an ordinary 15-degree drop-forged wrench to turn the die, as shown in the sketch.

New York. H. J. BACHMANN.

[The shape of milling cutter shown by Mr. Bachmann was finally adopted by one concern making large numbers of small brass gears, to mitigate the trouble caused by girl operators carelessly dulling the cutters. At first the tool room kept the cutters sharpened, but so great was this work that it was resolved that the girls should be made to do it themselves so they would be more careful about running the cutters into the arbors, etc. By making the teeth of the peculiar shape shown the labor of grinding is reduced and there is less tendency to grind the cutting face slanting backwards. This is an example of reverting to what is generally regarded as uneconomical practice, *i. e.*, making each employe sharpen his own tools, but for very good and sufficient reason apparently. —EDITOR.]

HORSE POWER OF DETACHABLE LINK DRIVING CHAIN.

Editor MACHINERY:

The accompanying table lists the horse powers of driving chains, comparing the link belt with Jeffrey Mey-Oborn chain, which are both about the same size, as they will work on the same sprocket wheels. The horse-power of driving chains is a subject which I have never been able to get very much satisfaction on, as the makers stand to the working strain in their catalogues and the questions of friction and jar take considerable of the strain given as safe. So whenever it has been my good fortune to use these chains I have watched them and made notes on the percentage to be deducted for ordinary service and friction. For example, take a case recently noticed: The chain was link belt No. 114, and, according to the table, it should be good to transmit a steady load of 15 horse-power at 250 feet per minute; it actually transmitted 14¼ horse-power at this speed with ordinary care. It broke at a strain transmitting 19¾ horsepower, so that this table is about correct with a deduction of say 5 per cent for friction when everything is new and in A1 condition.

Valley Park, Mo. W. O. RENKIN.

HORSE POWER OF DETACHABLE DRIVING CHAINS, SPEEDS GIVEN IN FEET PER MINUTE.

This Table gives values for ideal conditions. For ordinary duty deduct from 30 to 40 per cent.

DETACHABLE LINK BELT.				JEFFREY MEY-OBORN.			
Trade No.	Working Strain, No. Lbs.	Horse Power. 250 Feet	Horse Power. 500 Feet.	Trade No.	Working Strain, No. Lbs.	Horse Power. 250 Feet.	Horse Power. 500 Feet.
25	75	.56	1.125	25	100	.75	1.50
32	150	1.125	2.250	.....	.....	.....	.....
33	200	1.50	3.000	33	250	1.12	2.25
34	225	1.68	3.375	34	250	1.12	2.25
35	250	1.87	3.750	.....	.....	.....	.....
42	300	2.25	4.500	42	400	3.00	6.00
45	350	2.50	5.025	45	400	3.00	6.00
51	375	2.81	5.625	50	250	1.12	2.25
52	500	3.75	7.500	52	600	4.50	9.00
52½–55	450	3.37	6.750	55	600	4.50	9.00
57	600	4.50	9.00	52 spec.	800	6.00	12.00
62	650	4.87	9.75	57	700	5.25	10.50
66–67	700	5.25	10.50	62–67	750	5.62	11.25
75	750	5.62	11.25	75	1000	7.50	15.00
77	800	6.00	12.00	77	900	6.75	13.50
78	1000	7.50	15.00	78	1100	8.25	16.50
83–88	1200	9.00	18.00	83	1500	11.12	22.25
85	1300	9.75	19.50	85	1600	12.00	24.00
95	1600	12.00	24.00	88	1300	9.75	19.50
103–108	1800	13.50	27.00	103–121	2000	15.00	30.00
114	2000	15.00	30.00	108	2200	16.50	33.00
104½	2100	15.75	31.50	122–146	3000	22.50	45.00
122	2200	16.50	33.00	124	4000	30.00	60.00
124	2250	16.87	33.75	.....	.....	.....	.....

Formula used: $\frac{\text{Working strain} \times \text{feet per min.}}{33{,}000} = \text{H. P.}$

To find H.P. at any other speed up to 1000 feet per minute, proceed thus: Find H.P. in table for chain at 500 feet. Then multiply this H.P. by speed required and divide result by 500. Example: Required H.P. of chain M. O. No. 124 at 700 feet. Capacity of No. 124 M. O. chain at 500 = 60 H.P. Then

$$60 \times 700 \div 500 = 84 \text{ H P. at 700 feet.}$$

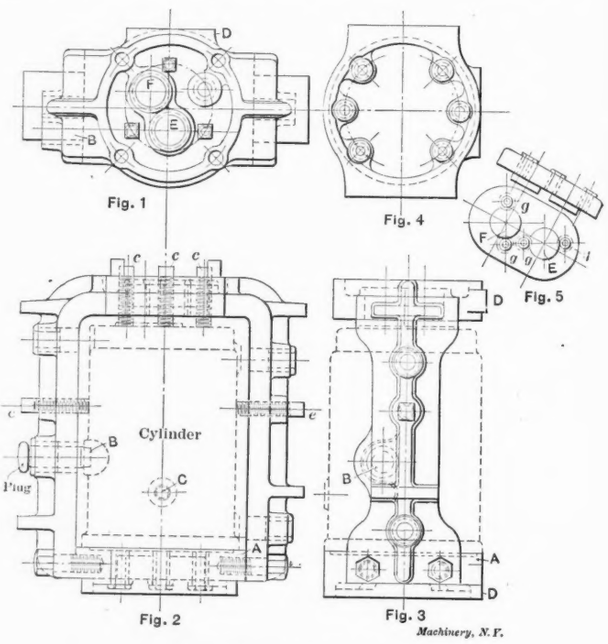
A GAS ENGINE CYLINDER JIG.

A. J. Brutsche.

Editor MACHINERY:

Figs. 1 to 5 show a jig used to bore, drill and tap a 2½ H. P. vertical gas engine cylinder. The jig must be strongly made with ribs and plenty of metal used throughout, to work successfully with this method of holding the cylinder. The first jig designed had neither the ribs nor the strength of this one, but as I thought was plenty strong enough. I soon saw my mistake, for at the first trial, in tightening the setscrews, *e*, the sides bulged slightly, and the same occurred with the upper setscrews. This last jig, however, overcame the difficulties caused by springing.

After the cylinder has been bored and faced it is placed in the jig with a dowel fit at *A* (the cylinder is shown dotted in Figs. 2 and 3). The tapered plug shown in Fig. 2 is driven into the cored exhaust port, *B*, the setscrews on the top and side are tightened, the plug slipped out, and the cylinder is



Jig for Drilling Gas Engine Cylinder.

ready for drilling. The plug referred to above is to locate and center the cylinder, for all the rest of the drilling is based on this exhaust port. This port, then, is the first to be drilled, after which the rest of the drilling is done as the jig is turned from side to side. After all the holes have been drilled the steel bushes are slipped out and the holes tapped. The tapped hole for the oiler at *C* has no bushing or guide, for it is only important to tap in the center of the boss, but the hole will always be at right angles with the ones on the side, because the jig rests on the legs, *D*. Fig. 4 shows the bottom of the jig, and the bushings for boring the bolt holes in the bottom of the cylinder. When the tapping is completed the setscrews are loosened and the cylinder taken out. The part of jig shown at Fig. 5 is then placed in the finished parts. *E* and *F*,

in the proper position, and the bolt holes, *g*, are drilled and tapped. This completes the cylinder, with all the holes parallel or at right angles to each other. A. J. BRUTSCHE.

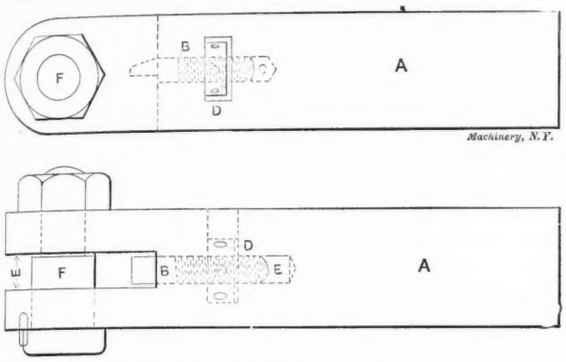
Dayton, Ohio.

A CUTTER HOLDER FOR SLOTTER.

Editor MACHINERY:

When a new concern is building its first machine for the market many schemes have to be resorted to; it is of one of these schemes I write. An involute gear was needed and it was decided to cut it on the slotter. Several forming tools were made and were not very satisfactory, principally on account of the poor quality of steel from which they were made. Then the plan here illustrated was tried and found to work finely.

A holder was made as shown in two views in the cut, into which was inserted a B. & S. involute cutter of the ordinary



A Holder for using Gear Cutters in the Slotter.

type used on a gear cutter for roughing out, and another holder was made for the finishing cutter. The body, *A*, of the holder is a forging planed to fit the toolholder, on the slotter. The pin, *B*, is of machinery steel, threaded. The hole, *C*, is drilled so as to provide clearance for the pin *B*. The pin *B*, on being screwed down, acts as a stop to bring the cutter tooth which is to do the cutting into the correct position. As soon as one tooth became dull the pin *B* was raised and another tooth was turned into cutting position, and the pin lowered as before. The cutter to be used for roughing having an even number of teeth the pin was placed centrally. For the finishing cutter holder, however, the pin *B* had to be placed at an angle, the finishing cutter having an uneven number of teeth. The nut *D*, which operates the pin *B*, works in a slot cut through the holder *A*. The nut has ¼-inch holes for a key or spanner wrench. *E* is the slot for the cutter and *F* is the clamping bolt.

The above device was used and worked satisfactorily. The cuts taken were not of the heaviest, of course, but the gear when cut ran quite smoothly, that being the result in mind.

Ridgway, Pa. G. E. WHITE.

A DANGEROUS BOILER.

Editor MACHINERY:

The recent disaster on board the United States gunboat *Benningtон* reminds me of a case of neglected boiler sheets that happily did not result in a parallel disaster, but which for that reason alone seems most remarkable. The mill out of which the boiler was taken was located in New York City in a thickly populated district where, if the boiler had blown up, great loss of life would in all probability have resulted. When the weak condition of the boiler was discovered, it was immediately taken out, and as it was worthless for anything but scrap it was cut to pieces on the spot, in order to transfer it more conveniently. Walking down Bethune Street one day where the mill was located I was surprised at the light blows that were required to drive a cutting tool through the iron by a workman using a light sledge. Crossing the street I was amazed to find that for nearly the entire length of the boiler there was a thin place about 8 inches wide which in thickness was not more than 1-32 of an inch. The thickness gradually increased on each side until it reached the full thickness of the sheet. I was still more astonished when the foreman of the mill told me that two days before the boiler was taken out it was running with a steam pressure of 60 pounds per square inch, and that a week prior the boiler had been tested with a hydrostatic pressure of 90 pounds per square inch, and that it showed no leak or sign of weakness discoverable. The boiler was about 30 feet long and the thin part extended nearly the entire length. In some places where the chisel had been driven through I took hold of the thin metal with my fingers and tore off pieces, and when we consider that this thin sheet had stood a water test of 90 pounds per square inch, it seems little short of miraculous. Two days before the boiler was taken out was the regular cleaning day and one of the men inside the boiler thought that the sheet sounded very thin. He struck it a light blow with a scaling hammer and the head penetrated the sheet and in several places he repeated this astounding feat. Upon reporting the dangerous condition of the boiler it was at once decided to take it out and in the process of dismantling it was found that the brick wall in which the boiler was set was built up against a bank in the cellar under the mill and that the bank was wet and springy. Water flowed in tiny streams along on top of the wall, and a gutter had been hollowed out in the bank to lead the water off, but it appears that enough had found its way through to corrode the exterior of the boiler and produce the condition described. Of course it is not wonderful that the corrosion of the plates described took place, but it is very strange that they should have stood a pressure of 90 pounds without rupture.

Syracuse, N. Y. C. E. MINK.

[Our correspondent does not state the diameter of the boiler, but it probably was one of the small diameter type that was largely used forty or fifty years ago, and its small diameter is what in all probability saved an explosion. It is the thickness of the sheet relative to the diameter that determines the factor of safety. For example, a sheet 1 inch thick would be an absurdity for a boiler shell 60 inches in diameter, carrying 100 pounds per square inch, but for a boiler of the Scotch marine type, say 10 feet diameter, it is none too much. Supposing that the boiler described by Mr. Mink was 20 inches diameter, it follows that the bursting stress at 90 pounds per square inch would be $\frac{20 \times 90}{2} = 900$ pounds per lineal inch of the sheet. A good quality of iron having a tensile strength of 40,000 pounds per square inch might stand this pressure, even if only 1-32 of an inch thick, because it is not probable that the reduction in thickness was uniform. It is not to be denied that the condition discovered was extremely dangerous, but the point to be made is, although seemingly miraculous that the accident did not occur, it can probably be explained on entirely practical grounds, and conversely there will invariably be found some good and sufficient reason for the so-called "mysterious" boiler explosions of which we hear so frequently. —EDITOR.]

* * *

The recovery of gold from sea water promises to be one of the *ignis fatuii* which inventors pursue with an ardor worthy of a better cause. The amount of gold in sea water is very small, averaging about one grain per ton. Of course if this could be extracted it would mean that almost unlimited quantities of gold could be added to the world's store for there are millions of cubic miles of sea water to draw upon. To show the impracticability of such extraction, a paper was presented by Mr. G. F. Beilby before the British Association for the Advancement of Science. Mr. Beilby showed that in the working of gold mines cyanide liquors are allowed to run to waste containing as much as 100 grains or more of gold per ton because with all the efforts of highly-trained chemists it has not been found profitable to extract it any closer. And slimes containing eighteen grains or so when run through zinc precipitating boxes still contain 1½ grains per ton, or fifty per cent more than sea water. That there is a possibility of refining the process of extraction to such a degree that we will be able eventually to draw on the inexhaustible source of gold found in the ocean no one can deny but it will have to be of a nature quite different from anything now known, for the mere cost of pumping water through any extraction apparatus would eat up most, if not all, of the returns.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

IMITATION GROUND GLASS.

To make ordinary glass in windows or the camera appear as ground glass take a lump of glazier's putty and dab the surface of the glass with it. The result will be a good imitation of the real article. WM. NEWTON.

Oneonta, N. Y.

TO PREVENT BLANKING DIES FROM EXCESSIVE WARPING IN HARDENING.

After the die blank is cut from the bar, machine all over, then heat to a cherry red and allow the same to cool. When cool, machine to finish size, and work out in the usual way. Pack harden the die and dip in a solution of one-third oil and two-thirds water. C. F. EMERSON.

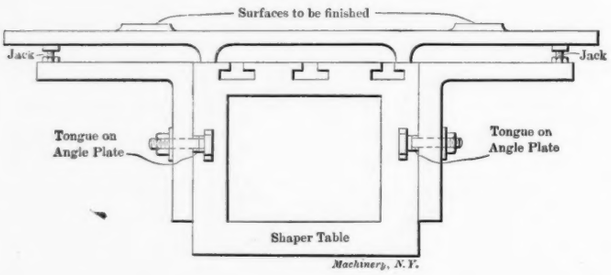
TO SOLDER BRASS OR STEEL TO STEEL.

To secure a permanent joint when soldering brass to steel or steel to steel, after polishing both surfaces, coat with your coppering solution (blue-vitriol and water), then apply the acid and apply the solder. This mode of treating the surface to be soldered is particularly valuable when filling in metal patterns or adhering a small piece to a large one.

Rochester, N. Y. CARROLL ASHLEY.

ANGLE PLATES TO EXTEND SHAPER TABLE.

Very often we get a job that is too long to be properly supported on the shaper table, and not having a planer we find it effective to bolt angle plates on either side of the shaper table

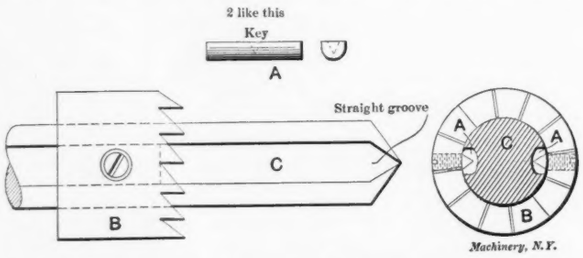


and use jacks in the usual manner. The cut shows the idea sufficiently well, so no further description is necessary.

Chicago, Ill. ROBERT A. LACHMANN.

COMBINATION DRILL AND COUNTERBORE OR FACING TOOL.

The straight-lip drill called the "Farmer" drill has its advantages, one of which is the drilling of brass, there being no need to grind off the cutting edges (as is the case with the twist drill) to prevent catching in the work. Where it is desirable to drill and counterbore or face at one operation, I find the Farmer drill excellent, for the simple reason that its straight flutes make a good driving medium; that is to say, they can be made to act as keyways very nicely. While I



admit that for steel, and even cast iron (especially for long drilling), the twist drill acts best, owing to the angle of the cutting edges, yet it is also true that for short holes the straight-lip drills act O. K. The form of key used is shown at *A*. *B* is the counterbore or facing cutter, and *C* is a Farmer drill. The combination tool will be found especially valuable in light manufacturing, but, of course, is also very handy for the general run of work. ROBERT A. LACHMANN.

Chicago, Ill.

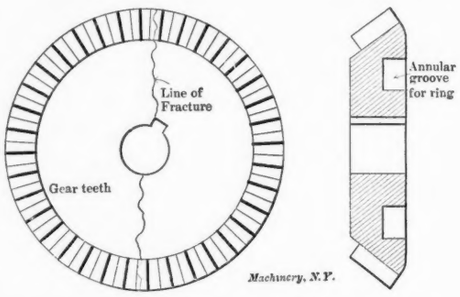
BICYCLE TIRE ANTI-LEAK.

The solid or some form of cushion tire is considerably used now by mechanics and others who ride their bicycles to and from the shop, in preference to the pneumatic tire because of its durability and freedom from puncture. But pneumatic tires can be made reliable and quite safe from punctures by using a liberal amount of the following cheap mixture: 1 pound of sheet glue dissolved in hot water in the usual manner, and 3 pints of molasses. This mixture injected into the tire through the valve stem semi-hardens into an elastic jelly, being, in fact, about the same as the well-known ink roller composition used for the rollers of printing presses. This treatment will usually be found to effectually stop leaks in punctured or porous tires. F. EMERSON.

Newark, N. J.

REPAIR OF A BROKEN BEVEL GEAR.

Some time ago I had a repair job on one of our machines, a bevel gear being broken as shown in the sketch. A new gear would cost about $2.75, and getting it would mean a delay of about a week. I put the broken parts of the gear together and caught it in a lathe chuck with the back of the gear out.



An annular groove was turned in the back, and then a steel ring was turned up to fit. When the ring was pressed into place the gear was stronger than when new. By this simple kink we saved $2.50 and a week's delay.

Cincinnati, Ohio. JOHN ASPENLEITER.

Someone has written: "A little drop of oil, a little bit of care; saves a lot of toil, avoids a lot of wear," which although it barely escapes being a platitude, is nevertheless worth remembering, especially with machines designed in the old way. The modern method of designing machinery, however, should be that of making each bearing self-lubricating so far as possible. The idea that all machines must necessarily require a lot of personal attention in the matter of oiling every bearing is nonsensical. There is no more reason why each bearing on high grade machinery, at least, should require personal attention than that a footbridge should be built without railings. Let the machine tend to its own lubrication and we make it much more efficient and durable. The constant need of attention to lubrication becomes a drudgery and is a waste of useful effort which might better be employed in increasing the output.

* * *

The reporter of a daily newspaper is generally a hard-worked man who is often asked to do the impossible, that is, make intelligent reports about things of which he knows little or nothing. It is not strange, therefore, that he sometimes "falls down" badly, when writing on things mechanical. Owing to a mix-up of some steers with a locomotive on the Lackawana recently, a freight train was derailed and part of an important shipment of the Crocker-Wheeler Co. was thrown about somewhat promiscuously. A local reporter visited the scene and seeing that halves of a large generator were displaced so that the planed surface of the joint was visible, he at once jumped to the conclusion that the frame was broken, and so reported. To his untrained eye the difference between a machined surface and a fracture was not apparent.

SHOP RECEIPTS AND FORMULAS.

This page will be used for the publication of shop receipts which the contributors know from experience to be practicable. Nearly all readers of MACHINERY can add something, and it is desired that they use this page as a medium for exchanging useful formulas, thus putting them on record for the general benefit of the craft. All published receipts are paid for.

110. TO RESTORE BURNT STEEL.

To restore burnt cast steel heat the piece to a red heat and sprinkle over it a mixture of 8 parts, red chromate of potassium; 4 parts, saltpeter; ⅛ part, aloes; ⅛ part, gum arabic; and ¼ part, resin. A. A.

111. USE OF TURPENTINE FOR WOUNDS.

The machinist often cuts or bruises his hands and by having a small bottle of turpentine handy he can at once bathe the injured part, which will relieve the soreness and perhaps protect from blood poisoning. F. H. JACKSON.

Angelica, N. Y.

112. CEMENT FOR CAST IRON.

To make a cement for cast iron take 16 ounces cast-iron borings; 2 ounces, sal-ammoniac; and 1 ounce, sulphur. Mix well and keep dry. When ready to use take one part of this powder to 20 parts of cast iron borings and mix thoroughly into a stiff paste, adding a little water. A. A.

113. MIXTURE FOR MAKING PLUG COCKS TIGHT—SAME FOR GLASS STOPPERS.

To make an anti-leak and lubricating mixture for plug cocks use 2 parts of tried suet and 1 part of beeswax melted together; stir thoroughly, strain and cool.

A mixture for making glass stoppers tight is made by melting together equal parts of glycerine and paraffin.

Worcester, Mass. L. S. BURBANK.

114. TO PREVENT HANDS CHAPPING IN WINTER.

The winter season is now starting in and a machinist's hands are apt to get sore and stiff from exposure. Take a four-ounce bottle and put in same 3 ounces glycerine, 1 ounce alcohol, and from 20 to 30 drops of carbolic acid. After washing the hands, and while they are a little damp, apply a few drops and thoroughly rub it in. A good time also to use it is at night. F. H. JACKSON.

Angelica, N. Y.

115. LIQUID COURT PLASTER.

At your druggist's procure an ounce bottle and have him fill it three-fourths full of flexible collodion, and fill up with ether. Apply to cuts, bruises, etc., and it protects them and will not wash off. If the ether evaporates, leaving it too thick for use, have more ether put in to liquefy it. It is a good thing to have in the house; also the tool chest.

Angelica, N. Y. F. H. JACKSON.

116. ACID TEST FOR IRON AND STEEL.

A simple acid test for iron and steel is made as follows: The sample to be tested should be filed smooth or polished. Then place it in dilute nitric or sulphuric acid for from 15 to 20 hours; then wash and dry the sample. The best steel then has a frosty appearance; ordinary steel has a honeycombed appearance; and iron presents a fibrous structure in the direction in which it has been worked. A. A.

117. RUST PREVENTIVE FOR TOOLS.

The following I have used for a number of years, and found it O. K. in every respect. Take a pound of vaseline and melt with it 2 ounces of blue ointment—what druggists call one-third—and add, to give it a pleasant odor, a few drops of oil of wintergreen, cinnamon, or sassafras. When thoroughly mixed pour into a tin can—an old baking powder can will do. Keep a rag saturated with the preventive to wipe tools that are liable to rust. F. H. JACKSON.

Angelica, N. Y.

118. WATER- AND OIL-PROOF CEMENT.

Some time ago I built a gasoline engine and boat, but when I put the rig on the river I found the engine would run for a short while and then stop. I found that the cause was some sand holes in the cylinder which admitted water into the bore of the cylinder. To stop the holes I used litharge and glycerine mixed to a stiff paste. The cement soon got as hard as iron and I had no further trouble from leakage. I found that this cement is better than anything else I have ever tried.

Dayton, Ky. ALBERT ELMIGER.

119. ETCHING FLUID.

I have found the following receipt for a fluid for etching steel to be very satisfactory, both for frosting effect and deep etching. Mix 1 ounce sulphate of copper, ¼ ounce alum, ½ teaspoonful of salt (reduced to powder), with 1 gill of vinegar and 20 drops of nitric acid. This fluid can be used either for etching deeply or for frosting, according to the time it is allowed to act. The parts of the work which are not to be etched should be protected with beeswax or some similar substance. S. C.

120. STEEL WELDING COMPOUND.

A good compound for welding cast steel is made as follows: 41½ parts, boracic acid; 35 parts, common salt; 20 parts, ferrocyanide of potassium; 7½ parts, resin; 4 parts, carbonate of sodium. Heat the pieces to be welded to a light red heat and apply above compound, then heat to a strong yellow heat and the welding may be accomplished in the usual manner. A. A.

[The usual precaution applies, of course, in the use of the above, the same as with any of the cyanides, and that is to avoid breathing the poisonous fumes.—EDITOR.]

121. CEMENT FOR ATTACHING SOFT RUBBER TO IRON OR OTHER METALS.

A cement which is effective for cementing rubber to iron and which is specially valuable for fastening rubber bands to band-saw wheels is made as follows: Powdered shellac, 1 part; strong water of ammonia, 10 parts. Put the shellac in the ammonia water and set it away in a tightly closed jar for three or four weeks. In that time the mixture will become a perfectly liquid transparent mass and is then ready for use. When applied to rubber the ammonia softens it, but it quickly evaporates, leaving the rubber in the same condition as before. The shellac clings to the iron and thus forms a firm bond between the iron and the rubber. M. E. CANEK.

Altay, N. Y.

122. LUBRICANTS FOR REDRAWING SHELLS.

Zinc shells should be clean and free from all grit and should be immersed in boiling hot soap water. They must be redrawn while *hot* to get the best results. On some shells hot oil is sometimes used in preference to soap water.

For redrawing aluminum shells use a cheap grade of vaseline. It may not be amiss to add that the draw part of the redrawing die should not be made too long, so as to prevent "too much friction," which causes the shells to split and shrivel up.

For redrawing copper shells use good thick soap water as a lubricant. The soap used should be of a kind that will produce plenty of "slip"; if none such is to be had, mix a quantity of lard oil with the soap water on hand and boil the two together. Sprinkling graphite over the shells just before redrawing sometimes helps out on a mean job.

C. F. EMERSON.

* * *

It would appear that the rosy prospects for enormous power development at Victoria Falls at South Africa, have been somewhat overestimated, if we are to believe what Prof. Ayrton says regarding the dependable power of this great cataract. It appears that the volume of water falling over the falls is a greatly variable quantity, whereas that of Niagara is very constant. At the periods of minimum flow, Prof. Ayrton estimated that the available power of the Victoria Falls is only about one-tenth that of Niagara, where we have been lead to believe that it was over four times as great. Prof. Ayrton thinks the prospects for profitable transmission of power from the Victoria Falls to Johannesburg are very doubtful. In November, at the period of minimum flow, the available power from the falls is as low as 300,000 horse power, if the whole volume of water is utilized.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

3. D. C. T.—I would like to see formula for red and white writing solutions for blue prints. Something that will not spread on prints as ink does on blotting paper.

4. R. K.—Will you kindly give me some information through your columns regarding the welding of steel on the iron backs of shear blades and whether the shear back is made from the bar or by some other process?

5.—Draftsman.—I have a celluloid protractor which causes me considerable trouble by warping so that it does not lie flat on the drawing board. Is there any remedy for this?

A.—We referred this question to the Whitehead & Hoag Co., Newark, N. J., manufacturers of celluloid specialties. They replied as follows: Warping and curling of celluloid articles like protractors cannot be prevented in the manufacture. We have found it very difficult to prevent this under certain climatic conditions, as, for example, when there is a sudden change in weather. Warm weather especially affects the celluloid. In case of warping or curling, however, your inquirer will find that by laying a piece of heavy paper over the article and using a hot iron he can press it into shape.

6. C. E. G.—A number of subscribers would be pleased if you would explain why data sheet No. 48 was made an odd size, so that it is impossible to fold it with the other sheets. From time to time we have seen articles in MACHINERY and various other mechanical papers explaining the advantage of having catalogues, data sheets, and other information of a uniform size. Now, in the face of all this you issue a data sheet which it is impossible to fold with anything.

A.—The reason data sheet No. 48 was made an odd size was because the material that it contained was of such a nature that it was impossible to arrange it upon standard 6 x 9 sheets. It was therefore a case of either withholding this sheet from our readers or else of giving them the valuable formulas that it contained on an odd size sheet. We chose the latter course.

7. V. V. W.—Must a dynamotor, or motor generator, be used to charge storage batteries? If so why? I wish to get a ¼ horse power motor to run a small lathe, the motor to be run by storage batteries, what voltage would require the least number of batteries to run the motor? How many cells would be required to run the motor at 110 volts? Could the motor be used as a dynamo to recharge the batteries?

A.—It is not necessary to use a motor generator to charge storage batteries, any source of continuous electric current can be used if the voltage is high enough. To charge one cell, or any number connected in parallel will require an e. m. f. of about 3 volts. If the cells are connected in series, the e. m. f. of the charging current should be at the rate of not less than 2.2 volts per cell. The amperes of current required to charge the cells will depend upon their capacity. If the current is small it will require a long time to charge. Too strong a current cannot be used, however, without injury to the cells. This is also true of the discharging current. Information as to the proper current for charging and discharging can be obtained from the makers of the battery. b. The smallest number of cells that could be used to run the motor mentioned is one, but in that case the motor would have to wound for an e. m. f. of 2 volts, which would make the armature wire entirely too large for so small a machine. The best number of cells would be about 10, connected in series, so as to give a voltage of 20. Any of the storage battery manufacturers will give you data as to the size of cells for such a case. To operate a 110-volt motor would require about 60 cells connected in series, but each cell would be of very small size. The battery can be recharged with the motor, but the speed of the latter would have to be considerably higher than that at which it runs as a motor.

8. J. I. S.—I note with interest the question of J. S. S. in the August issue on hardening 6-inch milling cutters and the answer thereto by Mr. E. R. Markham. Why does Mr. Markham advise taking the cutter out of the warm oil and holding it over the fire? With such treatment I should expect that a cutter of this size would break as the thin edges would expand much more rapidly than the body. Why not leave the cutter in the oil until it is cooled down, and then start a fire under the oil and draw the cutter to the desired temper?

Answered by E. R. Markham, Cambridge, Mass.

A.—When a piece of steel is hardened internal strains are set up by the unequal contraction; some parts of the metal try to go in one direction and others in another. Sometimes the stresses are not sufficiently great to manifest themselves, but again they may cause the hardened piece to break some hours or even days after the piece has hardened. It is a well-known fact that a bar of hardened steel may be sprung if it is heated somewhat, and mechanics often take advantage of this fact to straighten reamers, counterbars, etc., that have sprung in hardening. Now, if a piece of hardened steel is taken from the bath and immediately placed over the fire and the outside is heated to a temperature of 300 to 400 degrees F. this portion becomes somewhat yielding and as a consequence the exterior will conform to the interior stresses without breaking or cracking. Of course the operator must not heat the piece so rapidly as to suddenly expand the small projections, but must do it slowly. Every mechanic who has occasion to harden large pieces of steel knows the danger of not removing internal strains. Very small pieces do not have these internal strains to any extent, but pieces of large size must be reheated in order to give internal stresses an opportunity to adjust themselves.

* * *

DEPTHS OF U. S. STANDARD AND "V" THREADS

Most screw tables in common use do not give the depth of a thread directly, it having to be found by subtracting the root diameter from the outside diameter and dividing the remainder by 2. Thus to find the depth of thread on a U. S. standard 1-inch screw it would require subtracting 0.8376 from 1.0000 and dividing the remainder, 0.1625 by 2, which operation gives 0.0812 as the depth of the thread. Mr. Edward R. Barker, of Worcester, Mass., has contributed the above table, which gives the difference between the root and outside diameters directly, and we have extended it so as to give the depth of a thread directly.

DEPTHS OF UNITED STATES STANDARD AND V THREADS.

Threads per inch.	Double Depth U. S. S.	Depth U. S. S.	Double Depth V Thread.	Depth V Thread.
40	.0324	.0162	.0433	.0216
36	.0360	.0180	.0481	.0241
32	.0405	.0203	.0541	.0271
30	.0433	.0216	.0577	.0289
28	.0463	.0232	.0618	.0309
26	.0499	.0250	.0666	.0333
24	.0541	.0271	.0721	.0361
22	.0590	.0295	.0787	.0394
20	.0649	.0325	.0866	.0433
18	.0721	.0361	.0962	.0481
16	.0811	.0405	.1082	.0541
14	.0927	.0464	.1235	.0618
13	.0999	.0499	.1332	.0666
12	.1082	.0541	.1443	.0722
11	.1180	.0590	.1574	.0787
10	.1299	.0649	.1732	.0866
9	.1443	.0722	.1924	.0962
8	.1623	.0812	.2165	.1082
7	.1855	.0928	.2474	.1237
6	.2165	.1082	.2886	.1443
5½	.2361	.1181	.3149	.1574
5	.2598	.1299	.3465	.1732
4½	.2886	.1443	.3848	.1924
4	.3247	.1624	.4330	.2165
3½	.3711	.1856	.4948	.2474
3	.4333	.2166	.5773	.2887

* * *

The fact that white mice are abnormally sensitive to gasoline vapor makes them valuable as detectors of gasoline leaks on submarine boats. The *Youth's Companion* says that the moment the air becomes contaminated with the slightest odor of gasoline the mice will begin to squeak and show general signs of discomfort. For this reason they are, it is alleged, used by the British Government on all submarine boats and each boat is allowed a shilling a week for their maintenance.

MACHINERY AND TOOLS.

A MONTHLY RECORD OF NEW APPLIANCES FOR THE SHOP.

THE BULLARD "RAPID PRODUCTION" BORING MILL.

The increasing use of high speed steels has introduced changes in the design of machine tools in more than one direction. Not only has it made necessary the use of larger bearing surfaces, stiffer design and a more liberal distribution of cast iron, but it has also called attention to the advantage of furnishing the workman with every facility for handling the work, and making the necessary changes in speed and feed adjustments and setting of cutting tools on the machines. Suppose that in doing a certain piece of work the actual time

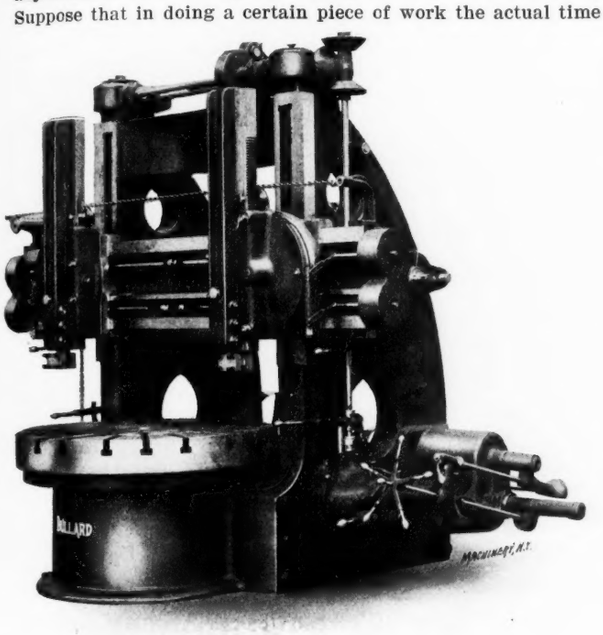


Fig. 1. Front View of Boring Mill.

spent in cutting is three hours, while the time expended in setting up the work and making various adjustments is one hour; twenty-five per cent of the time is then lost. If, as is entirely within the bounds of possibility, improvement in the design of the machine and the use of a tool steel of greater capacity should reduce this cutting time to one and a half hours, while the time for setting up, etc., still remains at one hour, the waste time would be increased to forty per cent; thus the improvement which increases the ability of a machine tool to take heavy cuts also makes the providing of facilities for handling the machine easily and rapidly a matter of great moment. The Bullard Machine Tool Co. of Bridgeport, Conn., have recently built a boring mill in which, for the reasons outlined above, special attention has been paid to this matter. The half-tones and accompanying description will explain those features of the machine which bear on this point.

Figs. 1 and 3 are front and rear views respectively of a fifty-four-inch boring mill. Starting first with the drive to get a general idea of the arrangement of the machine, power is furnished in the case illustrated by a motor mounted in a cradle set between the housings at the rear of the machine. This motor, which is run at a constant speed, is belted to the driving shaft below it, from which the motion is transmitted by gearing to speed box *A* seen in Fig. 2. A double cone of gears at this point provides for five speed ratios. From here a horizontal shaft transmits motion to the enclosed headstock mechanism, consisting of a system of gears and positive clutches operated by means to be afterward described. This allows a further choice of three ratios, thus giving a total of fifteen speeds to the table from a single speed motor.

Fig. 2 shows very clearly the arrangement of the operating handles of the machine. This arrangement has been made on what the builders call the "automobile principle." If the reader has a vivid imagination perhaps he may descry the location of the steering wheel, spark controller, throttle, speed change and reverse levers, and other accessories of the controlling mechanism of the horseless carriage. The phrase of course implies that the handles are all within easy reach of the operator in just the same way that the controlling mechanism of the automobile is within easy reach of the chauffeur. In Fig. 2, starting with the arrangement for changing the speed of the table, pilot wheel *B* operates the mechanism in speed box *A*, giving five changes. By lifting handle *C*, which projects from the center of this pilot wheel, a brake may be applied to the table, stopping it instantly at any desired point. Disk *D* interlocks the shaft above it in such a way as to make it impossible to operate this brake unless the gears in the speed box are disengaged from the spindle driving mechanism. Handle *E* may be given three positions to correspond with the three changes of speed obtainable in the headstock. Disk *D* again interlocks with this handle and the shaft on which it is mounted, making it impossible to change the positive clutches in the head stock except when the table is stopped and the brake set. It would thus seem to be impossible for the workman to seriously damage the machine, no matter how evilly disposed he might be.

Handle *F* operates a feed box mechanism similar to that commonly employed on lathes. Handles *G* and *F* together make a total of ten changes obtainable from the five gears in the cone of the feed box. The feed is reversed at *H*. From the feed box a vertical shaft transmits the motion to the gearing at the end of the cross rail. Through lever *J*, which operates a pair of friction clutches, the feed motion is applied either to the movement of the head on the cross rail or to the vertical feed of the ram. The friction clutches operate as a safety device, protecting the rest of the machine if for any

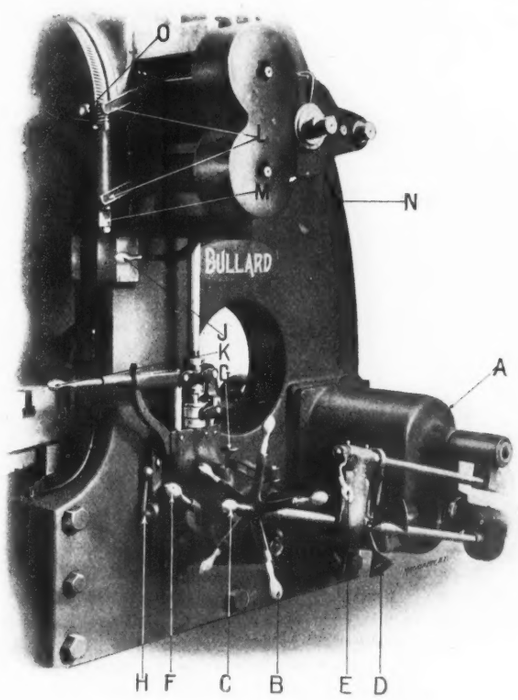


Fig. 2. Arrangement of Controlling Handles.

reason the heads are run together or the motion of the slides is blocked. Lever *K* provides for the rapid traverse of the tools, as may be seen more clearly in Figs. 1 and 3. The vertical shaft carries at its upper end a pair of friction cones which may be brought in contact with a similar cone on a high speed shaft extending across the top of the housings. The ram will be moved up or down, or the head will be moved in or

out, depending on the position of lever *J*, and on whether lever *K* is moved up and down. When this latter handle is in its central position the friction cones are disengaged and the feed mechanism is in gear. When either of the friction cones is engaged the feed from the feed-box is disengaged. The advantage of making the feed reverse in the feed-box at *H* will be appreciated by the workman, since the direction of the rapid traverse of the tool always bears a fixed relation to the movement given lever *K*. This is not the case in the usual design, where the change in direction of feed is made at the end of the cross rail.

The entire absence of hand wheels, cranks and slip gears will be noticed. Of course a fine hand adjustment is necessary for the accurate setting of tools. Provision is made for this on the traversing screw and the rack feed shaft by mounting on each of them an automatic friction grip *L*. Ordinarily the screw and shaft are free to rotate within the hubs of these levers, but when they are grasped by the hand of the workman they tighten on the screw or shaft and furnish a means for making minute adjustments. So far as the change of the spindle speeds, the handling of the table, and the movements of the right-hand head are concerned, everything may be done by the operator without stirring from his tracks. The feed mechanism, however, is duplicated on the other side of the machine for the left-hand head, since the operator would naturally stand on that side when adjusting the tools for that head.

The bearing of the head on the cross rail is designed in such a fashion as to allow the least possible amount of lost

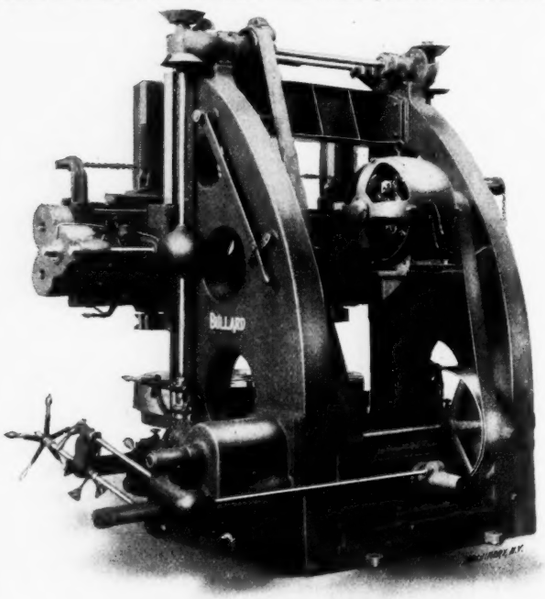


Fig. 3. Rear View showing Driving Mechanism.

motion. The head is guided by a narrow bearing at the lower end of the crossrail as may be seen from the front view in Fig. 1. The screw which feeds it along the rail is placed in the center of this bearing as is also the center stop, thus avoiding the possibility of any canting or cramping. The bearing at the upper side of the rail does not act as a guide, but serves to prevent the top of the head from being swung forward by the pressure of the cut on the tool. The crossrail is guided by the face of the right-hand housing in a similar manner. In raising and lowering the rail by power, the motor is stopped and lever *N* moved either upward or downward, depending upon whether the operator wishes to raise or lower the rail. The motor is then started up and the elevating screws are revolved to bring the rail to the proper location. The shaft which runs across the top of the housings and drives the elevating screws through bevel gears is driven by a spur gear mounted on a quill. This quill is pinned to the shaft at its center, thus making the torsional deflection the same at each side and keeping the crossrail parallel whether it is being elevated or lowered.

In Fig. 4 is shown an attachment which may be used either for taper facing or thread cutting. By comparing it with the end of the crossrail, as shown in Fig. 1, it will be seen that change gears have been mounted on the ends of two of the projecting shafts, and a quadrant attached for carrying intermediate gears. By this means a thread of any desired pitch may be cut, or, by making a simple change in the mechanism, the down feed of the ram and the cross feed of the head may be engaged simultaneously, the one feed working at a predetermined ratio with the other. This allows the turning of angular surfaces which are beyond the range of the swivel head. To facilitate thread cutting, the quick return may be used in running the tool back between the cuts. For this pur-

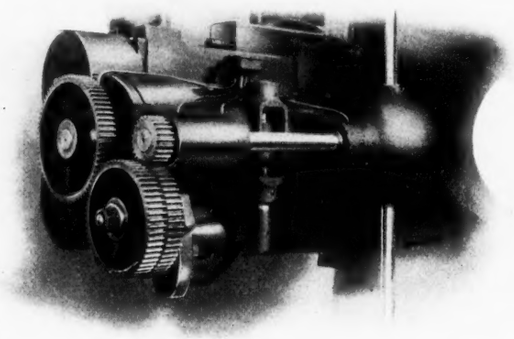


Fig. 4. Thread-cutting Attachment.

pose the clutch, controlled by quick traverse lever *K*, which connects the vertical feed rod with the feed gearing is made with one tooth, so that the position of the tool bears an unvarying relation to that of the work, no matter when or where the positive gearing may be thrown in. It is thus not necessary to reverse the table motion when cutting threads or scrolls.

As to the general construction of the machine, every care has been taken to make it durable and strong. The transmission gears run in oil. All the high speed shafts are ring oiling and are supported in bronze boxes. The table bearing is in the form of an approximation to the Schiele curve, and the provision for lubrication is such that the spindle runs in a bath of oil. The machine will handle work up to 56 inches in diameter and 42 inches in height. It occupies a total projected floor space of 92 x 124 inches.

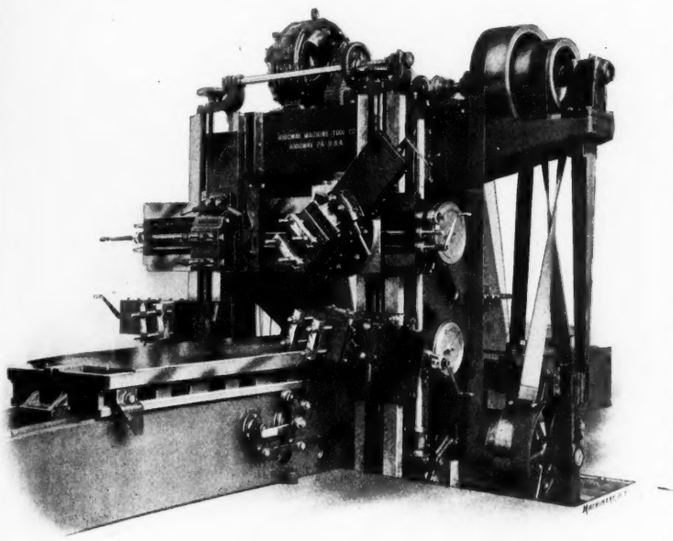
48-INCH x 48-INCH RIDGWAY PLANER.

"Massive construction" and "rigid design" are terms which appear with unvarying regularity in the descriptions of practically every new tool put on the market. Sometimes the use of these terms is justified, and sometimes perhaps it is not. The photograph of this Ridgway planer, of which a half-tone reproduction is shown below, gives one the impression that the term is not misapplied in this case at least, since the designer appears to have been granted a free hand as to the amount of cast iron he was at liberty to use, and apparently it has been used to good advantage.

The side walls of the bed are tied together with heavy cross girts, reinforced by double walls at the gear space. It is twice the length of the table, thus avoiding any overhang. The table is made in such a way that no chips or dirt can drop between the ways. The standard design provides for T-slots and reamed holes, but any other arrangement will be furnished without extra charge. The table is of box form and unusually deep. The large openings on the sides permit the withdrawal of the chips which drop into the interior. The rack is 11 inches wide and of 2 diametral pitch and the gearing is of steel throughout.

The uprights are finished to receive side heads, whether they are ordered or not, so the heads can be attached at any subsequent time. The cross rail is made in box form and is long enough to allow the head to traverse the entire width of the planer. In addition to the gibs on the outside edge of the housing face, there are also clamps on the inside, so the

strain of the cut is not transmitted across the face of the upright, where the cross rail is weakest. The side heads will travel entirely below the table and may be swiveled to any angle like those on the cross rail. And adjustment for the feed along the cross rail is made at the end of the cross rail and for the side head on the head itself. By means of a notched plate any desired feed within its range may be instantly obtained while the planer is in motion on its shortest stroke. No feed boxes are used, the reciprocating motion for any operation being obtained from the running gearing by a patented device which gives the maximum amount of feed



48-inch x 48-inch Ridgway Planer.

required with about 3 inches of table movement. Wherever possible the bearings are made self-lubricating. In a shop test the machine required 35 horse-power to carry four cuts one inch deep and one-eighth feed in cast iron.

With the arrangement shown in the cut, the motive power is furnished by a Thompson-Ryan variable speed motor. The machine was built to meet the requirements of Mackintosh, Hemphill & Co., of Pittsburg, Pa., and it weighed 75,000 pounds. The Ridgway Machine Tool Co., Ridgway, Pa., are the builders.

A ONE-BELT REVERSING COUNTERSHAFT.

Fig. 1 shows an exterior view and Fig. 2 a sectional drawing of a recently designed countershaft. The idea of the inventors is to do away with one belt and from two to three pulleys in the driving of any machine which requires that the motion shall be reversed. As may be seen from the half-tone the shipper actuates a double-ended thimble on the countershaft. As this thimble is moved outward or inward from the central position, the outer clutch levers or the inner clutch levers are

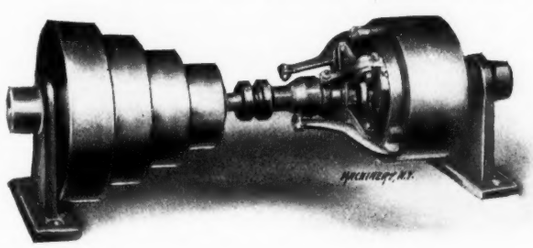


Fig. 1. One Belt Reversing Countershaft.

spread apart, thereby tightening the clutch surfaces to which they are connected and driving the countershaft ahead or backward, as the case may be. Referring to the sectional view, Fig. 2, a belt from the main line drives pulley *A*. This revolves loosely on the sleeve, *B*, which forms a box for the countershaft in hanger, *C*. Screwed and doweled to the inside rim of pulley, *A*, is an internal gear, *D*. This engages the teeth of pinions, *E*, of which there are three, equally spaced, mounted on studs in disk, *F*, which is keyed to sleeve *B*. Flange, *G*, rotates loosely on the shaft, carrying with it gear *H*, which meshes with pinion *E*. The outside of this flange is formed into a gripping surface for the inner pair of clutch levers, *J*. To the outside of pulley *A* is fastened a plate, *K*, bearing another gripping surface for the outside pair of clutch levers. The parts on which these two pairs of gripping surfaces are formed will thus be seen to be driven in opposite directions by the gearing, the speed of one being about twice that of the other. As the double-ended thimble is moved either to the right or to the left the shaft is clutched to one or the other of these two surfaces and thus made to rotate forward, or at a higher speed backward. The mechanism is enclosed in an oil bath.

This device is the invention of H. W. Ricks and George W. Stifel of Cambridge City, Ind. The invention may also be adapted for use as a reversing mechanism for gasoline launches. Blue prints and other information will be furnished to interested parties on application, as the patent is for sale outright or will be leased on royalty.

KEARNEY & TRECKER MILLING MACHINE.

A heavy-duty milling machine, of new design throughout, and which is adapted either for motor or belt drive, has been placed on the market by Kearney & Trecker, Milwaukee, Wis. This machine is the largest of a series of three of similar type and is unusually massive. The variation in speeds and feeds is obtained entirely by gearing, enabling a constant speed motor to be used or in the case of belt drive, a single driving pulley is all that is required and the machine can be belted direct to a main line shaft without the intervention of a countershaft or cone pulleys.

A characteristic of this milling machine is that the motor attachment can be made without resorting to any makeshift or any belt or chain connection between the motor and the machine. It will be noted that the pulley bracket interchanges with the motor and that the latter is standard with the exception of the head, which is made special, so that it can be bolted to the frame of the machine in place of the

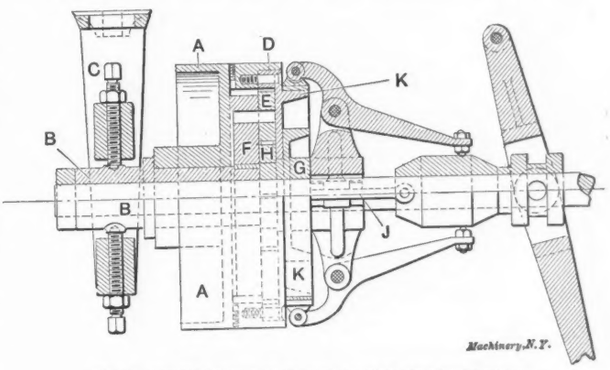


Fig. 2. Section through Gearing and Clutch Mechanism.

pulley bracket. When the motor is attached it is virtually a part of the machine, and looks as though it were a part of it, instead of an attachment. This type of motor drive has one advantage over special designs to suit the variable speed motors in that nothing special is required to convert the machine from a belt drive to a motor drive, or vice versa.

Another characteristic of the machine is the fact that it is entirely self oiling. The driving mechanism, the feed change gearing, and all bearings, including the spindle bearings, are oiled by means of a pump in connection with an oil reservoir in the base of the machine. This pump is a simple spur gear pump containing no valves to get out of order and it will supply a stream of oil so long as there is oil in the reservoir to feed it. Equally complete arrangements are provided for the lubrication of the cutters. Every machine, whether so ordered or not, is equipped with a pump and piping for lubricating the cutters and ample means for returning the lubricant to its reservoir in the base.

There are 18 spindle speeds provided, ranging from 13 to 320 revolutions a minute, or in this ratio, the exact speeds depending, of course, upon the speed of the driving shaft

The feed of the machine is taken from a constant speed shaft and provides a variation from ½ inch to 16 inches per minute.

Referring to Fig. 1, lever No. 1 is the starting and stopping lever. It engages a positive clutch with hardened teeth, which is used in preference to a friction clutch. Lever No. 2 has three positions and in connection with No. 3 which has six positions provides a geared drive with 18 changes of speed as stated above. Lever No. 3 is operated in connection with No. 4 which gives the connection below to the main driving shaft. The feed box is clearly shown in Fig. 3, there being two levers on top of the box and one at the end for giving the twelve changes in feed.

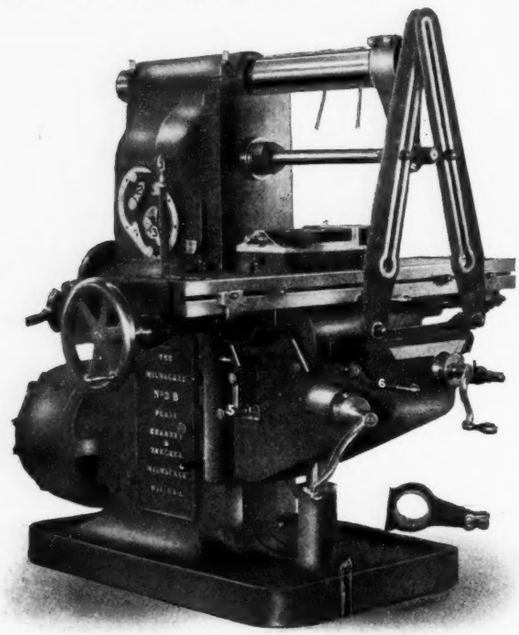


Fig. 1. Heavy Geared Drive Milwaukee Miller.

A locking lever 5 at the side of the knee in Fig. 1 is for positively locking out two feeds while the third one is being used; thus, when in the centered position, as photographed, only the table feed can be engaged, it being impossible to move lever 6 which engages and disengages the cross and vertical feeds.

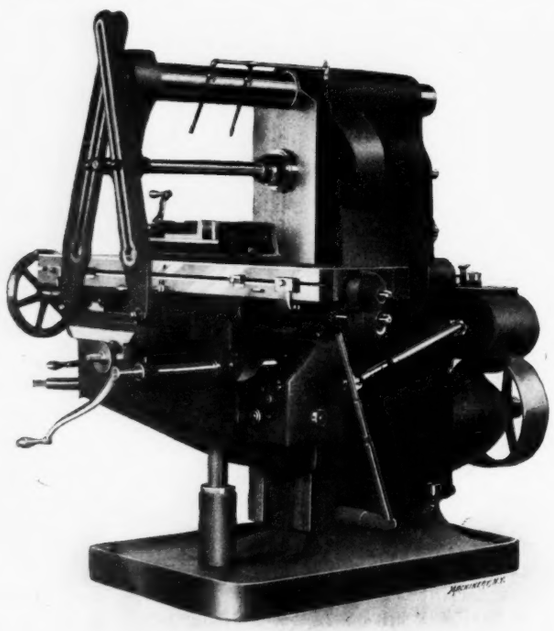


Fig. 2. Side View showing Feed Connections.

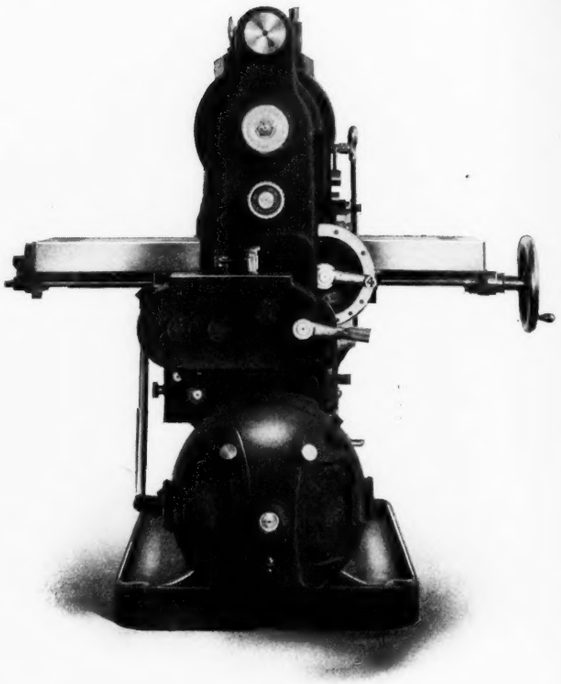


Fig. 3. Rear View.

The oil reservoir for lubricating the working parts is in the base of the column and is filled through the funnel shown near the bottom of the column in Fig. 2. The reservoir for the cutting lubricant is located in the closet of the machine from which it is forced to the flexible pipe that delivers it to the cutter. The table has a deep oil channel around its outer edge and screens which separate the chips from the oil, after which the oil flows to the saddle and down through the telescopic tubing (Fig. 2) and into the reservoir.

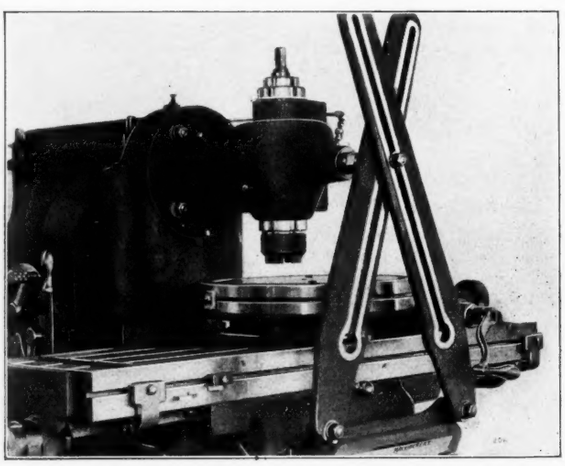


Fig 4. Vertical Milling Attachment.

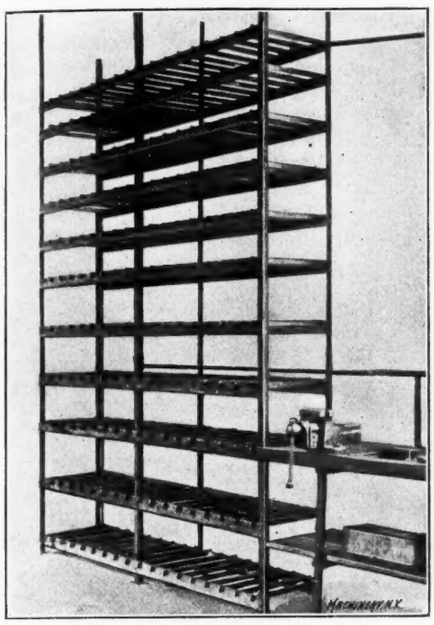
The machine may be equipped, if desired, with the rotary table and a vertical milling attachment shown in Fig. 4. This attachment can be ordered and placed on the machine after it has left the factory if so desired, without any trouble on the part of the purchaser. It will be noted that the slide of the machine is carried to the top of the column and that the base of the vertical milling attachment fits over this slide and is clamped to it, making an unusually rigid construction.

In providing for the electric drive an overload release attachment is supplied which breaks the circuit and stops the motor when the power delivered exceeds 10 horse power, this being all that should be needed or expected on a machine of this size.

The table has a longitudinal feed of 3 feet, a cross feed of 12 inches, and a vertical feed of 20 inches. The working surface of the table is 14 x 55 inches and the total weight of the machine with the motor 5,000 pounds.

A METAL STOCK RACK.

The illustration below is reproduced from a photograph made of a new metal rack, which is built by F. E. Wells & Son Co., Greenfield, Mass. This rack is made entirely of steel, the different parts of which are punched out on the press. This makes the cost so low that it can be furnished for about the same price as a wooden rack. The separate pieces are punched so as to lock together and in such a way



A New Metal Stock Rack.

that the rack can easily be knocked down for shipment. In setting it up, nothing is needed except a monkey wrench and the workman's two hands, with perhaps the occasional use of the hammer. Being made entirely of steel, it is fire proof, and so is very desirable for use in a stock room. It can be set in front of windows without shutting off the light, and is so constructed as to discourage the accumulation of dirt. When used for small parts the shelves are covered with sheet iron.

HORIZONTAL BORING AND DRILLING MACHINE.

The illustration shows the No. 3 horizontal drilling and boring machine built by Pawling & Harnischfeger, Milwaukee, Wis., which is one of four sizes or types of this machine that the builders make a specialty of. The table is supported on rails fastened to the same foundation as the column, and set at right angles to the spindle.

The constant-speed driving motor is fastened to the column carriage and directly geared to speed-change gearing in a revolving case. A spindle speed variation of 7 to 200 revolutions per minute is obtained with this device through eight changes. The machine is controlled by a positive clutch, the lever of which is placed conveniently for the quick reversal of the machine when used for tapping.

The column carriage or head is fitted with long bearing surfaces and is counterbalanced. The lowest position of spindle is 17 inches from the floor and an elevation of 8 feet 10 inches above this point can be reached. The table is 6 feet by 8 feet in size, and therefore a working surface of about 70 square feet can be covered with one setting. For long structural work, a small auxiliary table is used in connection with the large table.

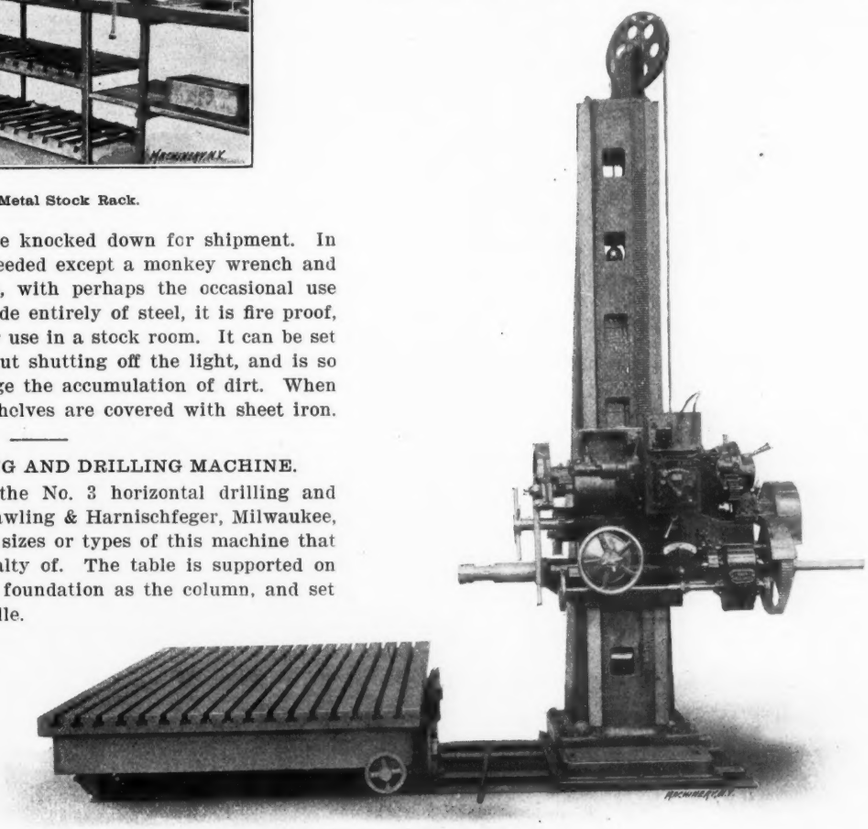
The spindle is of large diameter and contained in a substantial cast-iron sleeve. The bearings are bronze, of large area, and end thrust is taken by a ball bearing. The spindle sleeve has a very long bearing and there is an additional bearing for the spindle at the main driving gear, thus giving a rigid alignment at extreme spindle traverse. A cap nut is provided for holding facing bars and counterbores in the taper socket when feeding backwards.

A patented device is employed for locking and unlocking the feed mechanism which requires but a slight movement of the hand wheel for operating the spindle and setting the feed. There are four changes of gear feed for each spindle feed with a feed ratio of 0.008 to 0.07 inch per revolution of spindle.

The No. 1 and No. 2 machines have two round columns for supporting the carriage and are belt-driven from a variable speed countershaft which is under immediate control of the operator. The spindle and feed mechanisms are of same design on all machines.

AN ELECTRICALLY-DRIVEN PORTABLE DRILL.

The Thos. H. Dallett Co., of Philadelphia, Pa., have recently made improvements in their line of portable drills. These improvements involved redesigning the entire line and equipping them with a motor drive. As may be seen from the half-tone, the machine is supported by a base containing two bearings, one vertical and one horizontal, an arrangement which allows the machine to be used in either of these two positions. A stem which is clamped in this base carries on its upper end a

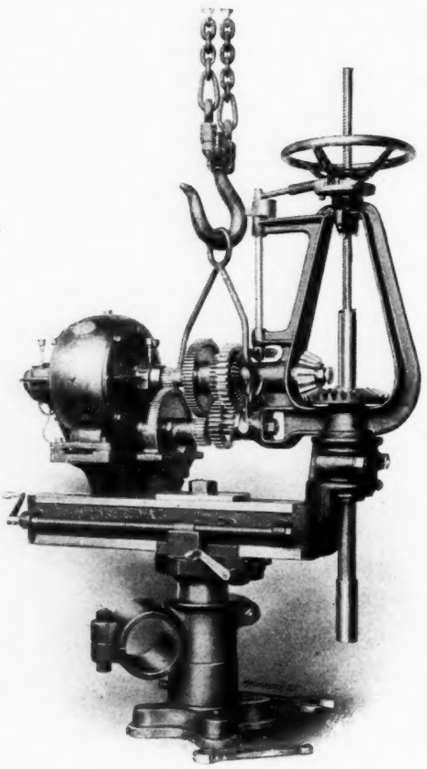


Pawling & Harnischfeger Horizontal Boring and Drilling Machine.

cap whose periphery is cut with worm teeth. The slide in which the frame of the machine is clamped carries a worm which engages this clamp. The drill may thus be rotated around the base, or moved in or out and clamped in the desired position. The inward and outward adjustment is actuated by a screw.

The motive power for this apparatus is a variable speed motor of sufficient capacity to take the heaviest cuts within the range of the machine without undue heating. Its bearings are arranged to work equally well in whatever position the machine may be mounted. The connection to the drill spindle is through powerful back gearing.. The feed of the drill is actuated through a pawl and ratchet mechanism which allows

a variation of from one tooth to seventeen by shifting a thumb latch, no wrench being required for its adjustment. There is a spring connection between the connecting rod and the pawl arm which it actuates and the tension of this spring may be adjusted in such a way as to give any desired amount of pressure to the feed; when this pressure is exceeded the feed becomes inoperative, the spring compressing at each revolution



No. 5 Dallett Portable Drill.

of the feed shaft instead of operating the pawl. A bail is hung in such a way as to allow easy handling of the apparatus by crane or hoist.

This machine at present is made in the No. 4 and 5 sizes. The No. 5 size, which is shown here, has a reach of arm of 36 inches, drilling at one setting over a surface of 72 inches outside diameter and 22½ inches inside diameter. The spindle is provided with a No. 5 Morse taper, has a diameter of 2 1-16 inches and a traverse of 20 inches with a range of speed from 19 to 90 revolutions per minute and feeding from .005 to .075 inch per revolution of the spindle. The net weight of the machine complete is 1,300 pounds.

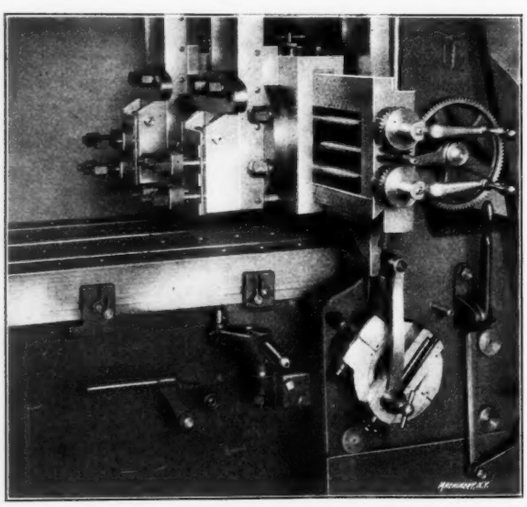
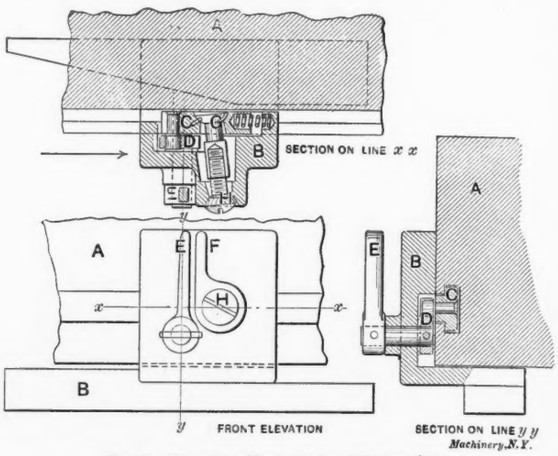


Fig. 1. Improved Shipper Dog as used on the Whitcomb Planer.

A QUICK ADJUSTING PLANER DOG.

Accidents sometimes occur in the use of a monkey wrench or box wrench when adjusting the shipper dogs to change the length of the stroke of the planer table. To obviate this danger and to allow the desired change to be made instantaneously, the locking and releasing being done by the pressure of the fingers only, the following device has been designed. Fig. 1 shows a planer with two of the dogs in position and Fig. 2 shows details of the construction of the clamping mechanism. In Fig. 2, *A* is the platen of the planer with a T-slot at the side in which the dog is clamped. A loose T-head tongue, *C*, fits in this T-slot. The spherically headed clamp nut, *G*, works in a seat in this tongue, and has screwed into it the adjusting screw, *H*, with a spherical head which seats in the body of the dog. Supposing that, as would be the case here, the blow of the shipper lever were in the direction of



Machinery, N.Y.

Fig. 2. Clamping Mechanism of Planer Dog.

the arrow shown in the top view. It is evident that this blow would make the clamp nut and its adjusting screw act as a toggle, thus firmly binding the dog to the table, being assisted in this operation by the pressure of the spring at the rear. When the workman desires to release the dog, lug *F* and lever *E* are grasped between the thumb and forefinger. Lever *E*, through the rock shaft to which it is pinned, rotates slightly the slotted arm, *D*, which in turn clasps a dowel which is riveted in the tongue, thus moving it to the left and freeing it from the tension of the clamp nut and adjusting screw. As soon as the pressure of the fingers is released the spring again forces the tongue to the left thus tightening the dog in its place, each successive blow from the shipper lever only serving to seat it more firmly. This arrangement is being applied by the Whitcomb-Blaisdell Machine Tool Co., of Worcester, Mass., to their line of Whitcomb planers.

THE PRENTICE AUTOMATIC TURRET MACHINE.

George G. Prentice & Co., New Haven, Conn., are building an automatic turret machine, of which a half-tone is shown in Fig. 1. The machine is used particularly for finishing brass, cast-iron and malleable-iron castings, and for doing second operation work on pieces made from bar stock. Its construction, however, is such that it may be adapted to a great many other uses. The machine consists essentially of a chuck, *A*, for holding the work, which can be revolved to bring successive tools into operation, and which can be moved in and out for the feeding of the tools; and in combination with this a series of spindles located at the left end of the machine in such a position as to coincide with the different positions of the work in the chuck. In the machine, as shown, there are four rotating tool spindles and five sets of jaws in the chuck. This latter is shown in detail in Fig. 2. A large face plate is slotted to receive five sets of double jaws which may be tightened on the work by means of right and left-hand screws. These jaws are dove-tailed to receive false jaws which may be bored or shaped to fit the contour of the work which it is desired to operate upon.

The long cast-iron sleeve, *G*, on the end of which this chuck is mounted, carries at its outer end the star wheel of a Geneva

stop motion, *J*, and a locking wheel, *K*, this mechanism being used for rotating the work from one position to another. The indexing mechanism is controlled by a long cam shaft running the length of the machine and driven by a worm and worm wheel *F*, which receives its motion from one of the spindles. When the machine is in operation this cam shaft rotates continuously unless thrown out of gear by the handle shown at the front of the bed.

There are four spindles in the form of machine here described. Of these, the one on the front side is driven by pulley *D*, the two lower ones by pulley *E*, while the further spindle, which is used for threading, is driven by the reversing pulleys, *C*. The various spindles may thus be given speeds to suit the tools which they carry.

The first member on the cam shaft, beginning at the right, is a disk carrying adjustable dogs for reversing the threading spindle. Next to that comes a cam which operates, through levers which may be plainly seen, the chuck rest, *B*. Since all the spindles revolve in one direction the pressure of the cut tends to rotate the work and the chuck in which it is mounted in such a way that the face of the notch cut in the face plate is brought down against this rest. These notches are milled with great accuracy to insure the alignment of the spindles with the work in the different positions. The top of the rest is in the form of a hardened shoe which has a taper adjustment by which it may be brought to the right

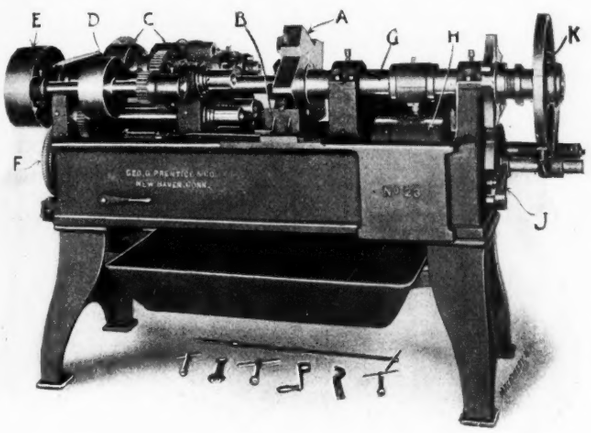


Fig. 1. The Prentice Automatic Turret Lathe.

height as the surface wears away. The office of the cam is to withdraw this rest just before the chuck is rotated by the indexing mechanism. Immediately under the tools is a drum on the camshaft which carries cams controlling the movement of the tap or die on the threading spindle, it being possible to use either the tap or die alone, or both together. A forked lever encircles the tap or die holder and carries at its lower end a roll engaged with the before-mentioned cam. The tap or die holder is free to slide on the spindle. This arrangement gives a positive lead to the threading tools, no matter what the feed for the turning tools may be. Since it is necessary that this lead be kept constant the cam shaft mechanism is generally driven from the threading spindle. When the tap and die holder are used together two cams and two forked levers are provided, a form of holder being used which will support both a tap and a die and allow them to act independently. At *H* may be seen a drum on which is mounted the feed cam. This cam is proportioned to give a thread long enough to take the longest cut necessary to finish the piece, and the proper feed is obtained by change gearing between the threading spindle and the worm shaft which drives the worm wheel, *F*. A sleeve on the chuck spindle carries the roller through which motion is communicated to the work, while the back thrust on the cam is taken care of by a second roller which may be seen in the cut near the right-hand bearing pedestal. The outer end of the cam shaft carries the indexing and locking mechanism, before described.

Much thought has been given to the design of the tools used with this machine. The combined tap and die holder has been mentioned. It is not necessary in using this tool that the external and internal thread should have the same pitch or the same length, the only requirement being they should both be the same hand. By using, however, an opening die holder on one of the spindles it would, of course, be possible to cut right and left-hand threads. The turning tools are so designed as to make use of self-hardening steel blades broken off from the bar and placed in the holder with no other machining than the simple removing of the scale and the grinding of the cutting edge of the desired angle. An example of one of these tools is shown in Fig. 3. This consists of a shank and body split in two parts, as may be seen in the end view, to allow a groove to be milled to receive the blade

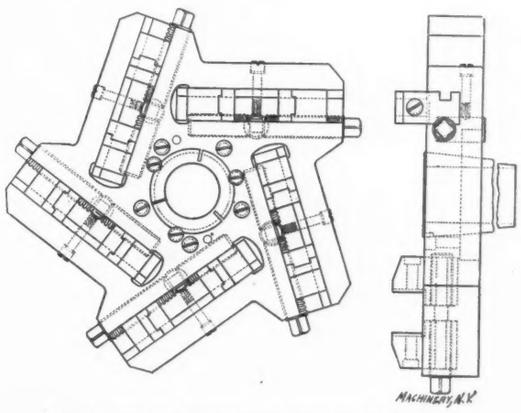


Fig. 2. Face Plate and Chuck Jaws for Holding Work.

of self-hardening steel which acts as a core drill. In the body are mounted four inclined blades whose ends are ground to perform the different functions of counterboring, chamfering the edge of the hole, facing the outer end of the casting and beveling the outside edge. By making the tool holders in this way the cost of replacing worn-out cutters is reduced to the smallest degree possible. Some of the other tools regularly furnished with the machines are, a cross-cutting tool for necking back of threads, etc., an automatic opening and hollow mill, universal adjustable box tool, and holders for solid reversing taps and dies. In the operation on small castings, such as pipe and valve fittings, injector parts, etc., the capacity of the machine is limited only by the ability of the workman to fasten the work into and take the work out of the machine. In second operation work on steel, for which a slightly different form of chuck or face plate is provided, the

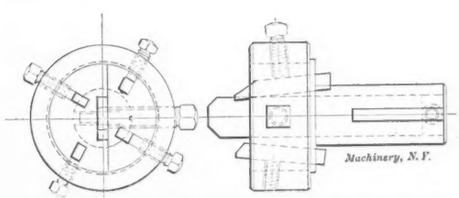


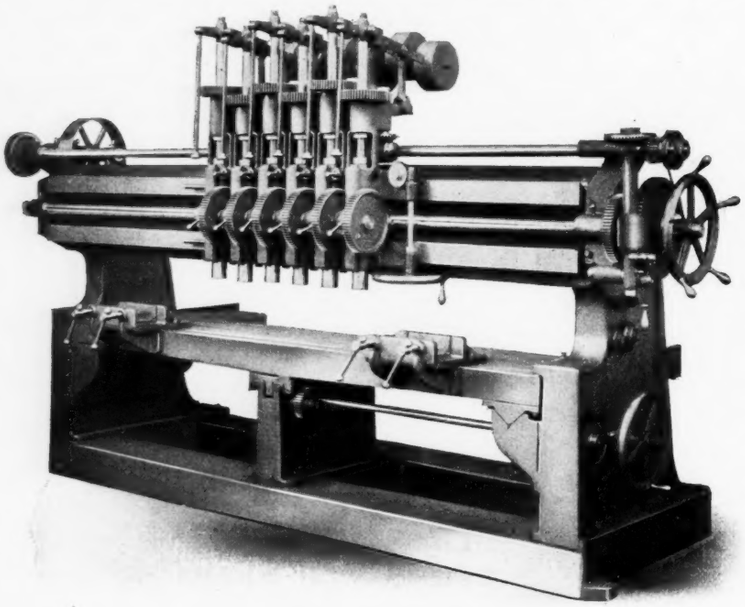
Fig. 3. An Example of the Toolholder Construction.

cuts are sometimes long enough so that one man can run two machines to advantage. The reason for providing five sets of chuck jaws and only four spindles is to allow a position where work will not be acted upon by the tool, thus permitting the workman time to change the work. The machine is not limited to the form we have shown, but may be furnished with three, four, five, six, or even more spindles when necessary, or may be made double ended with a revolving chuck in the center which grasps the work by the middle, allowing the ends to project each side, so as to be operated on at both ends simultaneously. Other arrangements for driving the spindles are also furnished to suit special work, but the machine as described is that which has been found useful for the production of the greatest variety of work.

A MULTIPLE-SPINDLE MUD RING DRILL.

This multiple-spindle drill press, while especially designed for handling the work indicated by its name, is equally well adapted to other operations requiring the drilling of a num-

ber of holes in one line. Instead of having the heads slide on an auxiliary rail, as is usual, they are directly adjustable on the main rail, thus enabling them to be spread to any desired center distance, by means of the independent adjustment provided. When it is necessary to move the heads on the rail collectively they may be clamped together by quick-acting nuts to the desired center distance apart; a dial on the worm wheel in the upper corner of the right-hand head shows the distance to be moved to the right or to the left.



The Bickford Mud Ring Drill.

The speed and feed changes are obtained by means of change gears held in position by spring plungers, thus enabling the operator to change quickly from one speed to another without lessening the available power of the machine. A dial on the large worm wheel at the right shows where to set the dog to trip the feed at any desired depth. The spindles are 1 15-16 inch in diameter with a vertical movement of 12 inches, and they work to a maximum center distance of 26¼ inches. The table has a traverse movement of 24 inches and when built with a 12-foot rail will take 10 feet 6 inches between the housings. Since it is driven by a constant pulley, the power is never less than that obtainable from a 5-inch double belt running at 1,619 feet per minute. The net weight of the machine is 17,500 pounds. This machine is one of the products of the Bickford Drill & Tool Co., Cincinnati, Ohio.

A SIMPLE SPUR AND BEVEL GEAR CUTTING MACHINE.

The Eberhardt Bros. Machine Co., of Newark, N. J., have designed and are putting on the market a gear cutter for handling spur and bevel gears up to twenty inches in diameter. The purpose of the makers was to produce a machine which should be as simple and inexpensive as possible and yet meet exacting requirements as to accuracy and output. The machine is not full automatic, though it requires so little attention that a boy may run several of them. As may be seen in Fig. 2, which shows the rear side of the machine, the drive is by means of belts with the speed change obtained by cone pulleys, and a take-up arrangement is provided for keeping the driving belt tight no matter what the position of the cutter slide may be, using endless belts throughout. The cutter slide may be tipped to an angle of 90 degrees for cutting bevel gears. The feed is thrown out automatically at the end of the cut. The lower slide is independently adjustable along the base to suit varying lengths of hub.

An important feature of the machine is the arrangement provided for indexing. In the hands of boys or unskilled men the arrangement used on the milling machine is liable to error, since it is easy to make a mistake and not drop the index pin into the right hole. On this machine, however, the indexing is done by one or more full turns of the indexing crank, change gears being provided for the different numbers of teeth. The index wheel is made in halves and special care is taken to have it accurate within very fine limits. The first gashing of the wheel is done with only commercial accuracy so far as the spacing is concerned. In bringing the spacing to the degree of refinement required for an index wheel, the teeth are finished in place by a hob having but a slight degree of relief. After the teeth have been gashed the two sections of the wheel are moved to a second position with relation to each other, the teeth being averaged up all around in the circumference to match with each other as nearly as possible. A cut is then taken with the hob to bring the indexing a degree nearer perfection than it was before. The two halves of the wheel are then moved to a third position in relation to each other and the tooth errors average up as above. After repeating this process as many times as there are possible adjustments of the two parts of the wheel, the error is reduced to a point far below that required for commercial work.

The machine shown has a capacity for gears twenty inches in diameter and five inches face. It will cut eight diametrical pitch from the solid in steel and six diametrical pitch from the solid in cast iron. The work spindle is of steel and is provided with a No. 10 Brown & Sharpe taper hole for receiving the various work arbors. A drawn-in bolt is provided by means of which the work arbors may be drawn in or forced out positively without hammering.

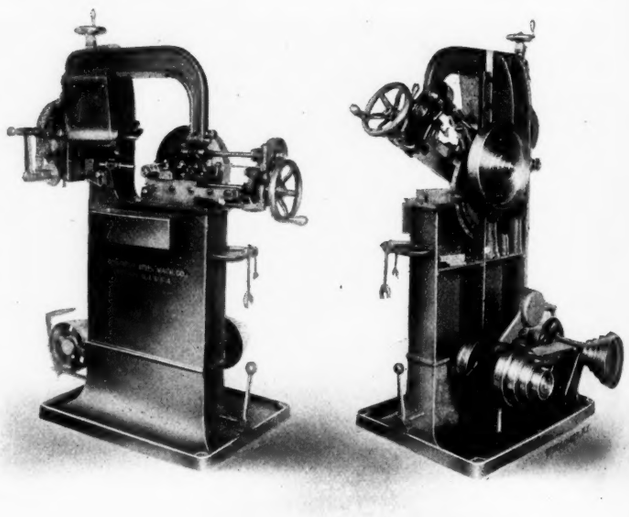


Fig. 1. Fig. 2.

Eberhardt Bros. Spur and Bevel Gear Cutting Machine.

A lathe center with dog driver is furnished for holding work on centers in connection with the outside support. This permits the cutting of gears on ordinary lathe mandrels and the doing of miscellaneous work such as cutting solid pinions, taps, reamers, etc.

A SPECIAL THREAD-ROLLING AND CUT-OFF ATTACHMENT FOR THE AUTOMATIC SCREW MACHINE.

In making work of the class shown in Fig. 1 on the automatic screw machine, if it is desired to turn out the part complete at one operation, it must be made as shown, with the counterbored portion at the outer end and the threaded end next to the chuck; this necessitates the use of special tools for cutting the thread. Such a tool is that shown in Fig. 2, which is used by the Cleveland Automatic Machine Co., Cleveland, Ohio, for doing this kind of work on their automatic screw machine. The thread is cut by rolling in a manner

somewhat similar to that in use for threading bicycle spokes, small screws, etc., except that the die in this case instead of being a flat plate with V-grooves milled in it, is a circular tool with a thread cut on its outside diameter as shown at *D* in Fig. 2. This roll, which is carried across underneath the work at *B*, is made of a diameter two, three, or four times as large as the work, thus having a double, triple, or quadruple

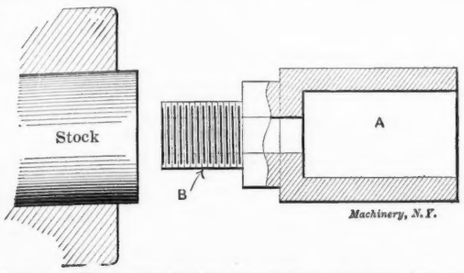


Fig. 1. Type of Work requiring the use of Thread Rolling Attachment.

thread cut upon it. For instance, if it be desired to roll a thread a half inch in diameter by sixteen pitch, the tool may be made one inch in diameter, eight turns per inch, with a double thread. If the work is threaded right-hand the tool must, of course, have a left-hand thread. This thread roll is mounted on an arm which is adjustable about the center of the cut-off tool by means of nuts, *A A*, one of which may be loosened and the other tightened to bring the tool into position to cut the desired depth. After the adjustment has been made, cap screw *C* is adjusted to support the tool under the

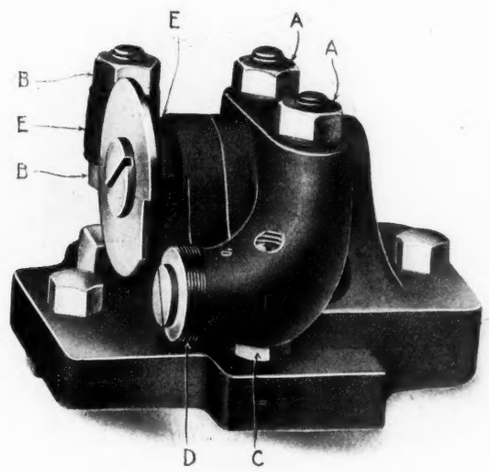


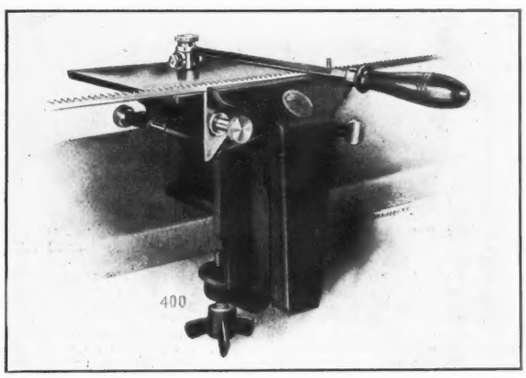
Fig. 2. Combined Tool Post for Thread Roll and Cut-off Tool.

pressure of the cut. In this tool is incorporated the regular mechanism used on the Cleveland automatic screw machine for supporting and adjusting circular cut-off and forming tools. The tool has formed in its side a series of ratchet teeth which mesh with similar teeth on lever *E E* in such a way that they are firmly bound together, and when lever *E E* is slightly turned about its axis the tool is turned also. To adjust the tool to bring its cutting edge to the center after grinding, one of the two nuts *B B* is loosened and the other tightened until the desired adjustment has been affected. This arrangement also serves to prevent the tool from slipping under the pressure of a heavy cut.

BAND SAW FILING DEVICE.

A neat and simple saw filing device has been brought out by the New Britain Machine Co., New Britain, Conn. Its purpose is to serve as a mechanical guide for the hand filing of band saws and it is said by the makers that results are secured superior to those obtained with power filing machines. The latter usually file the top of the teeth first and the cutting edge last. This causes the burr formed at the point of the tooth to be thrown outward at right angles to the blade, where it will be broken off as soon as the saw begins to run, leaving a dull point. If, however, the top of the tooth is filed last, as can be done in hand filing, the burr will extend in a direction lengthwise of the blade; in position it will be longer maintained and act as a keen cutting point.

In the New Britain device the band saw is held in an automatically operating vise, with hardened and ground jaws. A slight pressure of the file from left to right will carry a saw along with it as pressure in this direction tends to release the jaws and to permit the saw to slip. Attached to the vise is a horizontal table and this in connection with a roller guide fastened to the small end of the file constitutes the chief novelty of the device. This roller guide can be adjusted to support the file at any desired level and also will hold it at the proper angle for the desired hook to the teeth. These two adjustments may be changed with relation to each other and the file then securely clamped by setscrews. The hardened rollers of the guide travel on the face of the polished table and do not impede its action, yet they compel the work-



Band Saw Filing Device.

men to maintain the file in the correct position throughout the full length of the stroke. The whole process is therefore mechanically carried on except that of holding the file at right angles to the saw and the eye is, of course, a sufficient guide to accomplish this. The only adjustment that need be made is in setting the under gage to the back of the saw so that the teeth will project just enough to allow the file to pass freely through. This gage works in parallelism and is held by a single thumbscrew, for adjustment for different thickness of saws if necessary.

In order to maintain the saw teeth at a uniform height a piece of emery or stone should be brought up lightly against them while the saw is running and before it is removed from the machine for filing. This will indicate to the workman the point to which each tooth is to be sharpened and this guide, together with the fact that the teeth are always presented at a uniform height above the jaws by means of the under gage, enables him to secure uniformity.

TWO NEW INSERTED TOOL HOLDERS.

The accompanying cuts show two examples from a line of tool holders recently put on the market by the Bown Machine Co., Ltd., of Battle Creek, Mich. Fig. 1 is a side tool holder provided with a double ended blade. This, in combination with the swiveling head, allows the tool to be used either as straight right-hand, straight left-hand, offset right-hand, or offset left-hand of any desired depth of cut. The blade is made

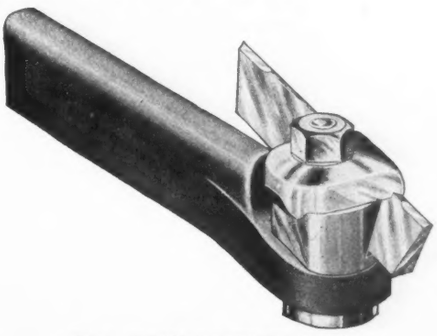


Fig. 1. Combination Side Tool Holder.

of high-speed steel. The holder itself is a drop forging from machinery steel, case hardened, the post and cap are machinery steel, and the collar is of hardened tool steel. The blade is supported on three surfaces in such a way as to be firmly held when the nut is tightened up.

Fig. 2 shows a planer tool. A novel feature of its construction is the provision made for varying the top rake of the

Fig. 2. Planer Tool with Adjustable Top Rake.

blade. By means of a tipping piece, similar to that in the regular lathe tool post, in combination with a swiveling clamp, the blade may be fastened firmly in any position desired. These tool holders are sent on approval and may be returned after examination if unsatisfactory, and the money will be refunded; or if one is broken by flaws in the metal, it will be replaced by the makers.

* * *

FRESH FROM THE PRESS.

PRACTICAL PATTERNMAKING, by Paul N. Hasluck. 160 pages 4¾ x 7 inches. 300 illustrations. Published in America by David McKay, Philadelphia. Price $1.

The author, who is a well-known English writer of books on technical instruction, treats of patternmaking from an English standpoint, and gives much interesting and valuable material that should be appreciated by the patternmaking craft generally and especially by apprentices and those who have not had the advantages of complete instruction. The book is copiously illustrated with pen sketches which show the various parts, and patterns for same, that were chosen for purpose of illustration. While some of these sketches are not drawn correctly, according to the recognized methods of mechanical delineation, as for example, the undercut of the pattern shown on page 42, they, in general, are clear. The book contains thirteen chapters as follows: Foundry Patterns and Foundry Practice, Jointing-up Patterns, Finishing Patterns, Circular Patterns, Making Core-boxes, Coring Holes in Castings, Pattern and Moulds for Iron Columns, Steam-engine Cylinder Patterns and Core-boxes, Worm Wheel Pattern, Lathe-bed Patterns, Headstock and Poppet Patterns, Slide-rest Patterns, Miscellaneous Patterns and Core-boxes.

THE SACRAMENTO VALLEY OF CALIFORNIA, by A. J. Wells. 112 pages, 4¾ x 6¾ inches. Illustrated with 116 half-tone illustrations and two maps. Published by the Southern Pacific Co., San Francisco, Cal. Price 10 cents.

This little booklet is issued by the Southern Pacific Co. to advertise the great empire of the Sacramento Valley of California. It is a well-written and beautifully illustrated booklet, and to any one interested in the possibilities of agricultural life in California it will prove valuable and interesting, and to any one else interested in the resources of this country in general, this book should be perused with profit. Mr. Wells' description of this section of California is detailed and care has been taken to make it thoroughly reliable and authoritative, avoiding exaggeration and matters that might be misleading. In addition to the descriptive portions the writer has given special chapters such as "A Great Empire and a Great Opportunity," "Why is the Valley not Densely Settled," "Cash Value of Climate," and "Social Life." A chapter of special interest in view of the reclamation work of the States and United States Government, is that on "The Delta Lands of the Sacramento." This chapter contains a good map of the region.

MODERN LOCOMOTIVE ENGINEERING, by C. F. Swingle. 630 pages 4¾ x 6½ inches; 265 engravings, bound in seal grain leather with flap and pocket. Title printed on cover in gilt edges. Published by Frederick J. Drake & Co., Chicago, Ill. Price $3.00.

The book is a "treatise" on the construction, care and management of the locomotive, to which is added a comprehensive chapter on the air brake, including the Westinghouse and New York systems. The subjects are not presented in the catechism style, but each chapter is followed by a list of questions which have their answers in the preceding text. The first chapter, Fireman's Duties, contains more technical matter perhaps than the average fireman would care about, but if he desire to obtain a knowledge of the theory of the steam engine it has none too much, being in fact, quite elementary from the theoretical standpoint. Following this chapter come the Boiler, Throttle and Dry Pipe; Valves and Valve Gear; Valve Setting; Piston Valves and Balanced Valves; The Indicator; Compound Locomotives; Injectors, Steam Gages, Pop Valve and Fittings; What to Do in Case of Breakdown; and The Modern Automatic Air Brake. Six folding plates are included, two of which are placed in the cover pocket. Judging from the somewhat critical examination we have given the chapter on valve setting, we think that the book is an unusually practical one and one that the railway foreman, engineer, machinist and master mechanic can possess with profit. It is not, as might be thought from the style of binding, a locomotive handbook containing a lot of condensed and tabulated data, but is a clear and interesting treatment of the subjects given above, written in an unusually readable style.

MACHINE DESIGN, by Albert E. Smith, Director of Sibley College, Cornell University, and Guido H. Marx, Associate Professor of Mechanical Engineering, Leland Stanford Jr. University, California. Published by John Wiley & Sons, New York. 369-8vo. pages, illustrated. Price $3.00.

This is primarily a text book for students' use. We have at various times heard favorable comment upon Prof. Smith's notes upon kinematics and machine design which he used when in California previous to taking the directorship of Sibley College. Now that they have been revised and supplemented by additional matter, sufficient to produce a text book, we believe they will meet with even greater favor than heretofore. The book is a model of conciseness and exact statements. It is entirely free from padding and adheres strictly to fundamental principles. In fact, a critic might say that it erred on this side, if at all. The first four chapters are devoted to a very brief treatment of the principles of kinematics; then follows a chapter upon the proportions of machine parts as dictated by stress, which gives the student an idea of the effects of repeated stress, shocks, steady loads, appropriate factors of safety, etc. After this the different machine parts are taken up in the following order: Riveted Joints; Bolts and Screws; Keys; Sliding Surfaces. Axles and Shafts; Journals and Bearings; Roller and Ball Bearings; Couplings and Clutches; Belts; Fly Wheels; Gearing; Springs; Machine Supports; and Machine Frames, the latter including, also, the subject of cranes. In many instances examples are worked out under the different formulas. For example, under the subject of belting, the case is taken of a single-acting pump of a certain size, which is to deliver a certain quantity of water against a given head. The pump is to be belt driven and the problem is to determine the width of the belt. By such problems as these the authors have indicated ways in which the book can be made of much practical value to the student, since the problems are of a character to suggest to instructors the kind of examples that are likely to prove of greatest benefit to the student.

NEW TRADE LITERATURE.

SCHUMACHER & BOYE, Cincinnati, O. Catalogue describing and illustrating instantaneous change gear lathes ranging from 18-inch to 48-inch.

GARDNER MACHINE CO., Beloit, Wis. Catalogue describing and illustrating their improved disk grinder No. 4, disk wheel press No. 4-14, and lever feed table. This catalogue is arranged in a binder so that additional sheets may be added as they are issued.

JACOBSON MACHINE MFG. CO., Warren, Pa. Bulletin A of Jacobson gas and gasoline engines. Short descriptions of the various types are given and the automatic horizontal gas engine is treated at length. The bulletin is well illustrated.

B. F. STURTEVANT CO., Hyde Park, Mass. A booklet entitled Mechanical Draft—What it is—What it does. This takes up forced draft and induced draft and describes various plants where fans for this purpose have been installed.

THE S. OBERMAYER CO., Cincinnati, Ohio, issue a monthly bulletin containing contributed articles upon foundry work besides advertisements of foundry supplies which they carry. It makes an attractive pamphlet and is sent free to any foundryman.

WATSON-STILLMAN CO., New York. Catalogue No. 67 made up of leaflets describing and illustrating their hydraulic accumulators. The hydro-pneumatic accumulator which they have been building for several years is illustrated and entirely redescribed on sheet 441.

WILLIAM JESSOP & SONS, Ltd., 91 John St., N. Y., new catalogue of Jessop High Grade Tool Steel. The points of superiority of this steel are pointed out, instructions for using are given, and the last pages are devoted to tables of sizes.

CROCKER-WHEELER CO., Ampere, N. J. Bulletin No. 61 describing belt-type direct current machines. Tables of standard low speeds, moderate speeds, net and shipping weights, etc., for some of the forms are given.

GOULD & EBERHARDT, Newark, N. J. Catalogue C of "High Duty" Shapers and attachments. A description covering the general class of High Duty Shapers is given, and special types and their attachments are described. Tables of dimensions are included and on page 37 are found suggestions for setting up shapers.

STANDARD ROLLER BEARING CO., Forty-eighth St. and Girard Ave., Philadelphia, Pa. Catalogue No. 12 giving price lists, illustrations, and detailed descriptions of the various types of bearings. On the last few pages are given some mechanical rules and metric conversion tables.

THE November issue of the Progress Reporter issued by the Niles-Bement-Pond Co., 111 Broadway, N. Y., contains descriptions of various tools among which are the following: large gun barrel drilling machines, plate planer with pneumatic clutches and some new styes of electric hoists.

THE INGERSOLL-SERGEANT DRILL CO., 26 Cortlandt St., New York City. Catalogue No. 73, entitled "Water Lifted by Compressed Air." This gives a thorough and interesting treatise on the air lift system, cost, advantages, where it is used, etc. Their various types of steam-driven air compressors are illustrated. Tables containing useful information for engineers are given in the back.

THE JEFFREY MFG. CO., Columbus, O. Bulletin No. 10 discusses electric mine locomotives. It is well illustrated with half-tones throughout. Tables and data for specifications are given in the back. Also Catalogue No. 20 of Coal Handling Machinery for mines. This is illustrated with half-tones showing details of their coal handling machinery and some of the machines in operation.

PATTERSON, GOTTFRIED & HUNTER, Ltd., 150 Centre St., New York City. Catalogue 45 on Power Transmission of Appliances. This is a pamphlet of over 250 pages listing a large line of supplies and appliances for power transmission carried on by this firm. It is fully illustrated and the items include pulleys of various kinds, hangers, couplings, clutches, belt tighteners, belting, sprocket wheels and chains, rope, gears, etc.

THE DERRY COLLARD CO., 256 Broadway, New York City, have in press an attractive book entitled "Eminent Engineers," by Dwight Goddard. It contains interesting biographical articles upon the achievements of 32 of the world's famous engineers who lived up to the time of George H. Corliss. These articles were previously published in leaflet form by Wyman & Gordon, Worcester, Mass., and have constituted the most interesting account of the work of engineers that has appeared since Smiles' Lives of Engineers appeared.

The American Locomotive Co., 111 Broadway, New York, have sent us a pamphlet containing a description of the Mallet articulated compound locomotive. This type of locomotive has been used in certain mountainous sections of Europe for several years past, but it is only recently that any noteworthy use was made of it in the United States, and that is the four-cylinder articulated compound freight locomotive built by the American Locomotive Co. for the Baltimore & Ohio Railroad about two years ago, and exhibited at the Louisiana Purchase Exposition of 1904. It is the heaviest and most powerful locomotive ever built, having a total weight of engine and tender of 477,500 pounds, of which 334,600 pounds are on the drivers. The maximum traction power when working compound is 71,500 pounds. The pamphlet is illustrated with half-tones and line drawings which are described in the accompanying text. It concludes with a number of interesting comments which appeared in various railway papers. The pamphlet is one well worth attention, for if we are not mistaken the type of locomotive which it describes will come to have considerable use on trunk lines having heavy traffic and stiff grades.

MANUFACTURERS' NOTES.

L. H. GILMER & CO., Philadelphia, Pa., have moved from Market St. into larger quarters in a more central location. Their new address is 504 Arch St., Philadelphia.

KEARNEY & TRECKER, Milwaukee, Wis., have recently completed a large addition to their shop, which will enable them to handle more easily their rapidly increasing business.

HISEY-WOLF MACHINE CO., Cincinnati, O., last month made the largest shipment of tools in their history. Their business is constantly increasing.